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# Progress in RANGE RESEARCH 17 Western States

FOR USE BY RANGE RESEARCH LEADERS

1960

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compiled by  
Cooperative State Experiment Station Service  
UNITED STATES DEPARTMENT OF AGRICULTURE



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This compilation progress and activity and semi-arid parts of the nation. Publication of research reviewed in subsequent editions from this compilation is the mission of the research reports. Reports are available only to State and Federal administrators.

The reports include information on production, management, plant variety and strain evaluation, water utilization studies are reported, they are an integral part of the progress information disseminated through the Western Conferences, and so on.

Research projects are omitted in this compilation, but reports of individual contributing projects are included. A list of recent range research publications is appended. A subject-matter index is included for the convenience of the reader.

The lengths of the reports are not necessarily indicative of the amount and concentration of the research they present, because most Federal reports are digested summaries of range research progress and some State reports are more condensed than others. If little or no additional information was obtained, a project reported in the 1959 compilation was not included in the 1960 edition.

In this second compilation combining range research information from the State Stations and the Federal agencies engaged in range research on drylands, procedural information and objectives or aims to be accomplished are included only for projects reported for the first time. The names of the project leaders are listed with their project reports, or in the case of some of the Federal reports, in a separate list. If a range scientist requires more information or answers to specific questions on a particular research or the problems being studied, he can write directly to a project leader. The reports are reproduced essentially as written by the respective project leaders or by the agency representatives who have coordinated the research progress information. Naturally, this has resulted in differences in style, format and detail of information included in this compilation.

An advisory committee has provided many valuable suggestions for the development and organization of this compilation. This committee includes - R. R. Humphrey and R. M. Love, representing the State agricultural experiment stations; Wesley Keller, D. L. Klingman, and J. S. Robins, representing the Agricultural Research Service; and E. H. Reid and W. O. Shepherd, representing the Forest Service.

Issued October 1961

Communication of research results on problems in the arid and semi-arid regions may or may not be published, statements or results without the express permission of the author, and copies of research or their

economics, fertilization, plant physiology, plant variety and their supplementary feeding studies are omitted unless they are the result of a range study. Research on the plants is being disseminated through the Alfalfa Improvement reports of pertinent regional



PROGRESS IN RANGE RESEARCH  
17 WESTERN STATES

1960

For Use by Range Research Leaders

Information was supplied from the following State agricultural experiment stations and Federal Agricultural research organizations. The men listed assembled the information from their colleagues for inclusion in this compilation.

State Agricultural Experiment Stations

|            |                   |              |                 |
|------------|-------------------|--------------|-----------------|
| Arizona    | - D. G. Wilson    | North Dakota | - W. C. Whitman |
| California | - R. M. Love      | Oklahoma     | - W. W. Huffine |
| Colorado   | - D. F. Hervey    | Oregon       | - C. E. Poulton |
| Idaho      | - E. W. Tisdale   | South Dakota | - J. K. Lewis   |
| Kansas     | - K. L. Anderson  | Texas        | - W. G. McCully |
| Montana    | - G. F. Payne     | Utah         | - C. W. Cook    |
| Nebraska   | - D. F. Burzlaff  | Washington   | - G. A. Harris  |
| Nevada     | - J. H. Robertson | Wyoming      | - D. R. Smith   |
| New Mexico | - K. A. Valentine |              |                 |

Agricultural Research Service, U. S. Department of Agriculture

Crops Research Division:

Crops Protection Research Branch - D. L. Klingman  
Forage and Range Research Branch - Wesley Keller

Soil and Water Conservation Research Division:

Western Soil and Water Management Research Branch - J. S. Robins  
(Now reorganized into several Branches within the Soil and  
Water Conservation Research Division)

Forest Service, U. S. Department of Agriculture

Division of Range Management and Wildlife Habitat Research - K. W. Parker

Final assembling, printing and distribution was done by the Cooperative State  
Experiment Station Service, U. S. Department of Agriculture.

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Cover page: Checking establishment and persistence of range grasses for high elevation range in Utah. (Courtesy of Agricultural Research Service.)



STATE AGRICULTURAL EXPERIMENT STATIONS

ARIZONA

Title: ANNUAL RING STUDIES OF DESERT SHRUBS (1959 - page 1)

Leaders: C. W. Ferguson and R. R. Humphrey, Department of Watershed Management

Progress: The project continued an exploratory investigation of growth rings of woody plant species in and adjoining the desert grassland of southwestern United States and northern Mexico. The study of nearly 200 species has indicated that a small percentage of these do have a definite annual growth ring. The knowledge of growth ring-environment relationships of species of positive value is being expanded in terms of length of chronology, number of species, and geographic area.

Title: RESEEDING OF ARIZONA RANGES (1959 - page 2)

Leaders: L. P. Hamilton, James Burrell and D. G. Wilson, Department of Watershed Management

Progress: One hundred and four germination counts were made at the Plant Materials Center to establish germination patterns of 35 range grasses. An additional 11,000 seedling counts were made to follow the dormancy pattern of a 1960 field collection of Lehmann lovegrass. Additional information was obtained on the use of fungicides, pre-chilling, and the effect of temperature and age and condition of the seed on germination. Results of 54 samples in the Plant Materials Center files were catalogued.

Under a separate branch of the project, point-distance and point-quadrat data was obtained over the state from plantings two to ten years old, principally in Cochise, Yavapai and Mohave Counties. Species and strain comparisons were rated at Holbrook, Linden and Hereford. The effect of reduction of annual competition and methods of covering Boer lovegrass were evaluated at Rancho Sacatal.

Title: SEED INCREASE AND PRELIMINARY EVALUATION OF PLANT INTRODUCTIONS THAT MAY BE SUITED TO THE SOUTHWEST (1959 - page 2) (W-6)

Leaders: L. P. Hamilton and D. G. Wilson, Department of Watershed Management

Progress: Plant introductions adapted to mild winters and to hot dry summers are sent to this Center for testing or increase. Growth characteristics and adaptation are noted. The seed and performance reports are returned to the Regional Plant Introduction Station at Pullman, Washington.



Three lines of buffel grass, P.I. 240,169 and P.I. 240,171 from Morocco and P.I. 243,198 from Southern Rhodesia are bushy range types having good seed production.

Eight lines of Eragrostis from South Africa (P.I.'s 207951, 208091, 208131, 208161, 208163, 208232, 209385 and 234218) produce leafy range types with good seed habits. They appear promising for further range testing.

Title: THE RANGE RESOURCES OF ARIZONA (1959 - page 4)

Leader: R. R. Humphrey, Department of Watershed Management

Progress: The work previously initiated in Pima, Pinal, and Santa Cruz Counties has been completed. Five vegetation types--pine-fir forest, juniper-oak woodland, chaparral, desert grassland, and southern desert shrub--are described on a basis of four condition classes - excellent, good, fair and poor. In most instances these are further subdivided and discussed on a basis of site classes. The bulletin includes (a) an analysis of woody plant invasion as a cause of deterioration in the desert grassland, (b) a section on management of each vegetation type to obtain maximum sustained yield of forage, (c) a section on control of woody plants, and (d) a discussion of the forage and management characteristics of the plants mentioned in the text. The bulletin is profusely illustrated with half-tone cuts, line drawings, and a five-color vegetation map.

Title: CHANGES IN THE DESERT GRASSLAND - AN ANALYSIS OF CAUSES  
(1959 - page 3) (W-25)

Leaders: R. R. Humphrey, Patrick D. Dalton, Donald E. Johnson and  
Joel E. Verner, Department of Watershed Management

Progress: Observations on habitat characteristics were recorded on three tobosa grass (Hilaria mutica) communities in three geographic areas that were distinct climatically, edaphically and floristically. Soil moisture and precipitation data were obtained at two locations on one of these sites from June 10, 1959 to September 2, 1960. The soil moisture analyses were made at four depths - 0.6", 6-12", 12-18", and 18-24".

Data have been collected on nine lines of creosotebush (Larrea tridentata) investigation: (1) distribution in Arizona, (2) composition of plant communities containing creosotebush, (3) anatomy and morphology, (4) factors affecting seed germination, (5) root ecology, (6) phenology, (7) leaf-moisture content, (8) growth inhibitors produced by creosotebush, and (9) effects of fire. Results of the study are currently being prepared for publication.

Title:       TRANSPIRATION BY RANGE AND WATERSHED PLANTS (1959 - page 5)

Leader:     David R. Kincaid and R. F. Wagle, Department of Watershed Management

Progress: Transpiration rates of arid-land plants have been measured as they relate to air temperature, light intensity and the vapor pressure deficit between leaf and air. These measurements were made at constant soil moisture tension. Although the transpiration rate generally follows the vapor pressure deficit, fluctuations caused by varying light intensities are quite apparent.

Title:       RESEEDING SEMI-ARID RANGELANDS IN ARIZONA - PELLETTED SEED VERSUS UNPELLETED SEED

Leaders:    O. D. Knipe, L. P. Hamilton, R. R. Humphrey and E. M. Schmutz, Department of Watershed Management. Cooperating with Bureau of Land Management and Crops Research Division, ARS. Dr. L. S. Adams, consultant

Objectives: A. Primary Experiment - Test the effectiveness of reseeding by airplane dissemination of pelleted and unpelleted seed on (1) land where no seedbed has been prepared; (2) a site, the soil of which is no coarser than sandy loam, which will have a seedbed prepared by pitting prior to seeding; and (3) a brush-infested site which will have a seedbed prepared and brush competition reduced by chaining prior to seeding.

Test the effectiveness of reseeding by drilling pelleted and unpelleted seed on a site, the soil of which is no coarser than sandy loam, which will have a seedbed prepared by pitting prior to seeding.

B. Secondary Experiment - Test the effectiveness of reseeding by airplane dissemination of pelleted and unpelleted seed on (1) land where no seedbed has been prepared; (2) a brush-infested site which will have a seedbed prepared and competition reduced by root-plowing prior to seeding; (3) a brush-infested site which will have been airplane-sprayed with a herbicide to reduce competition prior to seeding.

C. Supplemental Studies - (1) rodents, (2) insects, (3) artificial rainfall, (4) seeding before and after rainfall, (5) seed placement in interrupted furrows, (6) various size and shape of pits, and (7) asphalt mulch.

Progress: Two sites on Bureau of Land Management lands have been selected, fenced and plots located for seeding in June, 1961. The necessary equipment (climatological instruments, tillage and seeding equipment, air-seeding service, etc.) has been purchased or arranged for.



Germination tests (pelleted vs. unpelleted seed) are in progress and should be completed soon. Greenhouse studies, using soil from the experimental areas, designed to determine the optimum depth of planting and seedbed compaction for black grama and Lehmann and Boer lovegrass have been completed. These studies indicate that seed coverage of 1/8 to 1/2 inches and compaction of approximately three pounds per square inch are desirable for effecting emergence and establishment.

Title: SURFACED RUNOFF BASINS AS A SOURCE OF STOCK WATER ON SEMI-ARID RANGES (1959 - page 5)

Leaders: Sol Resnick, Institute of Water Utilization. Cooperating with Richard J. Shaw, Department of Agricultural Engineering, E. M. Schmutz and D. R. Kincaid, Department of Watershed Management

Progress: Recording rainfall and runoff records were collected for an asphalt-paved runoff area which has been in operation successfully for the past ten years. Excellent low-cost chemicals, screened by the ARS Southwest Water Conservation Laboratory researchers, along with the other materials commonly used for paving, will be tested for water yield and durability on a 4-acre area near Tucson.

Title: CONTROL OF NOXIOUS SHRUBS ON SOUTHWESTERN RANGES (1959 - page 6)

Leaders: E. M. Schmutz, R. F. Wagle and G. L. Ankam, Department of Watershed Management

Progress: 1. Cholla and Pricklypear cactus. After four years, continuing death loss of cholla sprouts is eliminating seasonal differences. Surviving sprouts now number only 50 to 190 per acre as compared to between 500 and 7,000 sprouts the first year. Sprouting does not show a consistent correlation with humidity, temperature or soil moisture but is influenced by seasonal rainfall.

2. Burroweed. Project inactive at present.

3. Oak-Chaparral. Multiple airplane applications of silvex were more effective than regular 2,4,5-T esters in killing fire sprouts of turbinella oak. Highest total kill, 44%, resulted from three consecutive-year light (1 2/3# per acre) applications. Lower total kills of 30, 7, 7 and 20% resulted from two consecutive-year light, two alternate-year light, single-year light and single-year heavy (5# per acre) applications, respectively. In general, topkill was 2 to 3 times greater and grass production increased markedly as shrubs decreased. Fenuron was effective at 16 and 32# rates (43 and 95% total kill) but monuron, urab and silvex granules gave poor results.



4. Creosotebush, Tarbush and Whitethorn. Hand-spray tests on these species with 2,4-D and 2,4,5-T herbicides continued to give high kills at low (1-2#) rates. With ground-rig applications, 4 to 8# rates were necessary to give effective kills (50-80%). Fenuron and monuron produced high (40-100%) kills at 8# rates; urab was intermediate; PBA and silvex granules generally produced low kills.

Title: SHRUB INVASION-FORAGE PRODUCTION INTERRELATIONS ON ARIZONA RANGELANDS (1959 - page 8)

Leaders: E. M. Schmutz, R. F. Wagle, D. W. Whitham and D. G. Wilson, Department of Watershed Management. Cooperating with Santa Rita and Tempe Research Centers, RMF&RES, Prescott National Forest and Arizona Game and Fish Department

Progress: 1. On a shrubby desert grassland range removal of all shrubs vs. burroweed and broomweed only did not produce significantly different results during the five-year period from 1954 to 1959. Both treatments increased grass density and grass production was increased from an average of about 400# to 600# per acre.

2. On burned and reseeded oak-chaparral lands during the three-year period from 1957 to 1959, various airplane treatments of shrub sprouts with 2,4,5-T herbicides reduced shrub growth and increased grass production an average of 655# per acre - from approximately 345# per acre on unsprayed plots to over 1,000# average for all spray treatments. The greatest increase of grass production, 1,030# per acre, resulted from three consecutive-year light (1 2/3# per acre) applications. The two alternate-year light, single-year light, and single-year heavy (5# per acre) applications produced smaller increases of 867, 448 and 278# per acre, respectively. Assuming 50% utilization, the grass increases would repay the respective costs of light applications in two or three years and the heavy application in seven to nine years.

3. On a mixed-grama grassland range, physical and chemical analyses of White House sandy gravelly loam soil show that in mesquite-invaded areas this soil is more coarse-textured while in the uninvaded areas this soil was significantly higher both in clay and organic matter and had a greater grass density.

Title: GROWTH VARIATION IN QUERCUS TURBINELLA AND ITS RELATION TO ENVIRONMENT (1959 - page 7) (W-63)

Leaders: Robert F. Wagle and David Whitham, Department of Watershed Management

Progress: 1. Soil collections have been made and soil fertility assays have been continued.

2. One series of plots in old growth (unburned in known history) turbinella oak has been treated with a series of macronutrients.

3. The effect of 25% fenuron applied in five different rates nearly two years ago has been analyzed. One pound of technical fenuron gave no appreciable effect; two pounds gave 57 and 24 per cent top and root kill, respectively; four pounds gave 77 and 43 per cent top and root kill, respectively; eight pounds gave 98 and 95 per cent top and root kill, respectively; 16 pounds gave results comparable to the 8-pound application of technical fenuron.

## CALIFORNIA

Title: EFFECTS OF BRUSH REMOVAL ON GAME RANGES IN CALIFORNIA  
(1959 - page 17)

Leaders: H. H. Biswell, A. M. Schultz, R. P. Gibbens and P. A. Jordan

Progress: On a deer winter range in Madera County an area which produced 50 pounds of browse per acre prior to mashing and burning produced 208, 283, and 180 pounds per acre in the first, second, and third years following treatment, respectively. On mashed but unburned areas yields were 247, 251, and 149 pounds per acre. Deer utilized 29, 48, and 54 per cent of the browse in the respective seasons.

On the above areas the number of brush seedlings surviving at the end of the third season were: mashed and burned - 8,600 per acre; mashed only - 500 per acre.

Fertilization of established brush seedlings increased mortality from 60 per cent on unfertilized plots to 73 per cent. Fertilization of mature wedgeleaf ceanothus plants caused increased growth and greater utilization by deer.

A collection of 60 does, half from manipulated sites and half from non-manipulated brush stands, did not reveal any significant differences between the two groups in the following measures: body weight, skeletal size, age distribution of samples, fetus counts, or adrenal gland weight. Fat deposits were slightly higher on deer from the manipulated area.

Title: BRUSH SEEDLING ESTABLISHMENT AND GROWTH IN RELATION TO SOIL FERTILITY LEVELS (W-25) (1959 - page 16)

Leaders: H. H. Biswell, A. M. Schultz, R. Q. Landers and Z. Naveh.  
Cooperating with R. M. Love and J. Vlamis

Progress: Leachates of the leaves and roots of chamise and litter from chamise stands were found to contain a compound resembling saponin in its activity, tentatively identified as a lactone. This compound affects the germination and root growth of Bromus mollis seedlings. At low concentrations germination and especially root growth are stimulated, and at high concentrations they are inhibited.



The substance is also found in the soil under and near chamise stands. It is believed to be the main reason why grass does not ordinarily grow under chamise.

Using B. mollis in bioassays of soils containing this inhibitor, it was possible to show differences in concentration between soils supporting chamise, soils of the neighboring grassland, and soils of the bare strip in between. Also there was a difference if the soil supporting chamise was shallow and sandy or deep and fertile.

Title: THE DEVELOPMENT AND HANDLING OF BROWSE SPECIES OF BRUSH FOR DOMESTIC LIVESTOCK USE (1959 - page 17)

Leaders: H. H. Biswell, A. M. Schultz, Steve Mason

Progress: Further studies were made of the feasibility of transplanting shrubs for browse. The results in transplanting confirm those earlier - that is, during the winter and early spring young shrubs can be lifted from one area (e.g. burned brush field) and planted in another nearby with very high survival, 85 per cent or more. Species transplanted to date include deerbrush (both Lake County variety and Sierra Nevada variety), wedgeleaf ceanothus, and Western Mountain mahogany.

These shrubs will withstand intense browsing after transplanting, but when protected from browsing they grow rapidly. Transplanted shrubs of deerbrush (Lake County variety) protected from browsing for five years have now attained a maximum height of 13.5 feet and are producing abundant seed. Other shrubs that have been under constant browsing have grown to a height of only one to two feet in four years. In the latter case, animals can browse over the entire tops, but in the former, when the plants become 13.5 feet tall, the animals can browse only from their lower portions. Just how long or how much shrubs should be protected from browsing after transplanting, if at all, needs further study.

Title: EFFECT OF ENVIRONMENT ON RESPONSE TO SELECTION IN SHEEP

Leaders: G. E. Bradford, G. M. Spurlock, D. T. Torell and W. C. Weir

Objective: To determine the relative improvement in performance of sheep for range conditions which can be made by selecting breeding stock, particularly rams, in the area of use as compared to those from a more favorable environment.

Progress: The ewes which constitute the foundation stock for this experiment were allotted to the four experimental groups in the spring of 1960. At the beginning of the breeding season there were 81 ewes in the Davis Selection group, 80 in the Hopland Selection group, 74 in the Hopland Control group and 63 in the D-H group (ewes at Hopland to be bred to rams from Davis Selection group). Ewes were assigned to the four groups at random within sire, age and flock of origin.



Ewes in all groups were bred to the same eight rams in 1960. The breeding season was June 15 to August 15 at Davis, and August 15 to September 19 at Hopland. Rams were penned individually with the ewes in both flocks. The lambs from these matings will constitute the first groups from which selections will be made.

Data from the yearling rams and ewes sired by the four rams used at both Davis and Hopland in 1958 did not provide any strong evidence of genotype-environment interaction. Progeny of four sires used in both flocks in 1959 and the eight used in 1960 will provide additional information on this point.

Seven yearling rams and seven wethers from Davis and 14 yearlings of each of these two "sexes" at Hopland were slaughtered in the spring of 1960 to provide information on the body composition of sheep raised in these two environments. Davis rams weighed approximately 45 pounds more alive than Hopland rams and had much fatter carcasses, but area of the longissimus dorsi muscle was essentially the same in both groups. This suggests that selection for body weight under the conditions provided in the Davis flock will tend to emphasize fatness more and muscling less than selection for weight at Hopland. This work is being repeated in 1961. Differences between rams and wethers in live and carcass weights were much greater at Davis than at Hopland, indicating a sex-environment interaction.

Title:       EFFECTS OF RANGE MANAGEMENT ON INFILTRATION, RUNOFF AND EROSION  
              (1959 - page 15)

Leaders:    R. H. Burgy, A. F. Pillsbury and M. R. Huberty (Davis)

Progress: Chemicals applied by the frilling method in April and May, 1960, on the Hopland II watershed were used to eliminate most of the larger woody species in the area. Runoff measurements indicated a pronounced increase in the duration of base flow from the area as a result of the treatment. Follow-up measures are required during the next two years to complete the conversion program.

Core drilling equipment acquired in 1959 was employed on the Placer County watersheds to install groundwater gaging wells for more complete measurements of total water yield from the study areas. Access tubes for nuclear probes were also installed in the area to provide measurements of water use by native vegetation.

Leaders:    A. F. Pillsbury, R. E. Pelishek, J. F. Osborn (Los Angeles)

Progress: 1. Plastic sheeting for pavement. The black 8-mil polyethylene sheeting at the Santa Rosa Ranch is still in place and in fair condition (approximately 80% intact). The work cooperatively with the Pacific Southwest Forest and Range Experiment Station pertaining to use of black plastic sheeting to pave phreatophyte areas, and to utilize lysimeters to evaluate effects on evapotranspiration, was terminated when James Patric of that Station was transferred to another region. It is hoped that this work will be reinstated in the future.

2. Subsurface moisture movement. The planned plastic film paved area, with network of neutron moisture meter access tubes, for evaluation of possible subsurface lateral flows was moved to a location near Tanbark Flats, and the installation was completed. Because a wildfire swept through the San Dimas Experimental Forest last summer and because of shortage of water, plans to artificially apply water above the paved area have been temporarily abandoned. We now await sufficient rainfall to obtain the data needed.

Title: FACTORS IN WATERSHED MANAGEMENT THAT INFLUENCE THE DISPOSITION OF PRECIPITATION AND YIELD OF WATER (W-32) (1959 - page 14)

Leaders: R. H. Burgy, A. F. Pillsbury and M. R. Huberty (Davis)

Progress: Measurements of evapotranspiration from a pair of lysimeters after the grass on and around one lysimeter was wetted by sprinkling provided comparative measurement of evapotranspiration under "wet-leaf" and "dry-leaf" conditions. Results of a series of 25 tests with the grass on and around the lysimeters green and actively growing indicated no appreciable difference in rates of evapotranspiration under "wet-leaf" and "dry-leaf" conditions.

In a second series of field tests with dead grass stubble superimposed on the green grass cover, significant differences in total evapotranspiration were measured.

A pair of weighing-recording, floating-type lysimeters were installed in a grassed area immediately adjacent to the Placer County watershed study area. Eight such standard raingages and access tubes for nuclear probes were installed in the area around the lysimeters.

Leaders: A. F. Pillsbury, J. Letey, Jr., O. R. Lunt, R. E. Pelishek, J. F. Osborn and E. H. Taylor (Los Angeles)

Progress: As found last year, ground litter detains rainfall for short periods of time over and above any amount stored, thus effectively lengthening the period of infiltration opportunity beyond periods of intensive rainfall. Laboratory model tests of this effect continue. With several litters one inch deep on slopes of 0, 5, and 10 per cent, appreciable quantities of water appear to be temporarily detained.

Other work is underway, including research on soil wettability and factors affecting it. Different formulations of spray-on soil-stabilizing materials are being investigated as to how they affect erodeability and permeability of the soil.



Title: RANGE CATTLE MANAGEMENT IN THE SIERRA FOOTHILLS (1959 - page 18)

Leaders: F. D. Carroll, W. C. Rollins, G. P. Lofgreen and K. A. Wagon

Progress: The foundation breeding herd was maintained on the University campus at Davis from July 7, 1959 to June 24, 1960. During this period one cow died and another was culled. Of the remaining 48 head, five were open as the result of an off-season breeding last year. Five of the remainder failed to conceive during the regular breeding season. One calf disappeared after birth, and another died from unknown causes. Fifteen steers and 21 heifers were weaned on June 24, 1960 with an average weaning weight and age of 402 pounds and 217 days, respectively. All of the heifers were retained as possible replacements for the breeding herd.

The University purchased the Forbes Ranch (5,040 acres) on June 1, 1960. The ranch is in the Sierra foothills about 19 miles east of Marysville. The area is to be developed into the Sierra Foothills Range Field Station, but in the interim is to be operated by the Department of Animal Husbandry. On June 24, 1960 the foundation breeding herd and 11 two-year-old purebred Hereford heifers from the University herd were moved to the new station. The 21 head of weaned heifers were moved to the station on July 6, 1960. All of these animals will be used to formulate a breeding herd for the new station.

Title: MANAGEMENT PRACTICES TO IMPROVE CALIFORNIA RANGE LANDS  
(1959 - page 19)

Leader: H. F. Heady

Progress: The sheep-deer pastures were operated for the fifth year. Deer alone in one pasture, or better stated as no sheep, has resulted in vegetational changes toward more tall annual grasses, such as soft chess, ripgut and wildoats. Where sheep grazed, the short grasses were favored. There may be more short grasses with continuous sheep grazing than with rotation grazing and more filaree with rotation grazing. However, these differences are so slight that it is unwise to say definitely that continuous and rotation grazing have significantly different effects on the annual range vegetation. Pasture fencing has been completed on the Dwight May ranch near Bridgeville in Humboldt County so that the effects of cattle grazing seasonally and continuously on Danthonia range can be studied.

Soil samples were taken in the original mulch plots this year to determine if mulch manipulation had affected the soil. Analyses are not completed, but nitrogen contents through the first three replications would indicate that the treatments are responsible for substantial differences in this element. Analyses will be made to determine if mulch manipulation influenced phosphorus, organic matter and other soil components.



Data was collected to determine the pattern of annual herbage increase during the growing season and decrease in the dry season without grazing. The study of vegetational changes was continued for the ninth year. The vegetation responded differently than in former years because of an unusually long drought period in the fall. Sampling of vegetation in Watershed II at Hopland was continued according to usual procedures and expanded to include the live-oak type.

Title: BIOLOGICAL CONTROL OF WEEDS (1959 - page 11)

Leaders: J. K. Holloway, Agricultural Research Service, and C. B. Huffaker

Progress: 1. Tansy ragwort - Senecio jacobaea. The cinnabar moth, Tyria jacobaeae, was introduced as larvae into Mendocino County in June 1959. Due to the spread in ages of the material, ranging from small to full-grown larvae, the feeding activity continued into early August. The moths successfully overwintered as pupae; however, the number was not as great as was desired. The first adult was observed in the field on June 6. On June 15 half-grown larvae were observed, indicating emergence must have begun about the last week in May. Indications are that the release site was not as satisfactory as it might have been. Unfortunately, due to drought conditions at the time of liberation, this was about the only location with sufficient growth to support the population of larvae. If satisfactory increase is not indicated in 1961, supplementary releases will be considered.

2. Scotch broom - Cytisus scoparius. A lepidopterous twig miner, Leucoptera spartifoliella, was released in El Dorado and Sonoma Counties in the first and second weeks of June. No recoveries have been made to date. This does not show that the insect failed to establish, as the immature stages of this insect are difficult to locate when the populations are low. The small white cocoons formed on the leaves and stems are reasonably conspicuous, so later in the year a concentrated effort will be made to check on recovery. Adult moths will be imported in 1961 for release in Mendocino and Nevada Counties.

Dr. Reece Sailer has been making observations on a seed weevil which occurs in the eastern part of the United States. Some research workers have indicated that Scotch broom could be considerably retained if effective seed control were available. Within the next year it is hoped that this weevil can be obtained for release in California.

3. Gorse - Ulex europaeus. Last year it was noted and reported that there was considerable plant mortality associated with the adult feeding of the seed weevil, Apion ulicis. In January 1960 in these areas of heavy feeding, bloom was reduced by more than 95%. In the fall of the year when the small flower buds were forming, adult feeding was observed and later it was found that many buds were discolored and failed to develop; the adult feeding in part accounts for the reduction in bloom. Such action on the part of the beetles greatly increases the competition for finding suitable seed

pods for larval development. However, this bud destruction was not noticeable until very dense populations had built up and dispersed. In fact, this could be why dispersal was slow at first and did not possibly take place until drastic competitive factors entered the picture.

4. Klamath weed - Hypericum perforatum. The status quo has remained somewhat the same except in Amador, Calaveras and Tuolumne Counties. These counties will receive attention to determine the cause of weed comeback and the reason for the continued reported high level.

San Diego County has had an infestation of Klamath weed for many years. It is now, however, reported to be spreading. In 1961, experimental releases of Agrilus hyperici will be made in this county.

When the root borer was originally released, Chrysolina quadrigemina populations were so heavy it was felt that no studies beyond checking recovery would be made. At present, however, the foliage-feeding beetles are less numerous and it is believed that this would be an appropriate time to make more detailed studies of the root borer and move it into locations in which there has not been maximum activity by Chrysolina.

Title: CONTROL OF POCKET GOPHERS AND OTHER RANGE RODENTS

Leaders: W. E. Howard and E. M. Brock

Objectives: To develop more economical and convenient means of controlling pocket gophers and other range rodents than now exist. In addition to developing new types of bait and testing their effectiveness under field conditions, it will be necessary to explore the following principles of rodent control in fairly large laboratory cages and also in the field: (1) mixture of bait materials, (2) bait shyness, (3) durable baits, (4) nontoxic - toxic bait combinations, (5) slow kill, (6) secondary poisoning, (7) odors or other attractants, (8) rodent associative memory, and (9) degree of kill.

Progress: The Modoc County low-volume rodent baiting machine (Loring White, "Low-Volume Machine Baiting for Rodent Control," California Department of Agriculture Bulletin 48(3): 189-192, 1959) was tested and found to be effective in scattering uniformly poison grain baits in a 40-foot swath when mounted on a pick-up which can travel 10 m.p.h. when applying the bait.

The meadow mouse (Microtus) population averaged about 96,000 open burrow holes per acre in a number of sections of this alfalfa field on Grand Island, Sacramento County.

Effective control was achieved when the hulled oat bait was made single kernel lethal (2 oz. of 1080 per 100 lb. of bait, or .125% 1080). Eight caged meadow mice fed a single kernel of .125% 1080 bait died (100%), whereas only 43 per cent of seven mice fed single kernels of .0625% 1080 bait died. Toxicity was reduced after bait was rained on.



Title: RELATION OF WILDLIFE TO AGRICULTURE WITH EMPHASIS ON RODENTS AND RABBITS

Leaders: W. E. Howard and E. M. Brock

Objectives: 1. To develop better means of controlling rodents and rabbits.

2. To determine when and where control of rodents and rabbits is needed with range improvement practices.

3. To measure the relationship of soil fertility to the population dynamics of rodents.

4. To study the effects of habitat alteration on wildlife populations.

5. To improve farmer-sportsman relationships.

Progress: 1. In our measurement of responses of rodents to range fertilization, about four times as many rodents of three species were trapped on the study plots in 1960 as in 1959, but the increase occurred similarly on both the fertilized and untreated plots.

2. Meadow mice populations were periodically checked near Tulelake and Alturas, and few mice were found in the traps.

3. The density of range rodents on Flourney Range Demonstration Project, Modoc County, in October was only 1.6 per 100 trap nights. This is the lowest density observed since the study started in 1955. The high in 1958 was 20.5.

4. The density of pocket gophers at Pomponio Ranch, San Mateo County, declined from 1,329 individuals in the study pastures in 1958 to a low of 207 in 1960, but began to increase again in 1960.

5. In an attempt to protect conifer seed spots from rodents, in cooperation with D. W. Muelder, nearly all seeds were still lost; but it was learned that some and possibly most of them were taken by invertebrates.

6. The cannon net proved effective and efficient in capturing domestic pigeons.

Title: THE DETERMINATION OF THE FERTILIZER REQUIREMENTS OF CALIFORNIA SOILS AS INDICATED BY POT AND FIELD TRIALS WITH THE AID OF LABORATORY STUDIES

Leaders: H. Jenny, A. Ulrich, J. Vlamis, A. D. Crocco, W. E. Martin and D. E. Williams

Objectives: 1. To promote a greater efficiency in the use of fertilizers in California.

2. To study effects of fertilizers on quality of crop.

3. To obtain data bearing on the possible correlations between chemical and biological examinations of soil conducted in the laboratory and response to fertilizer application in the field.

Progress: A study was conducted of the nutrient status of 21 upland soils from Madera County. The object was to provide data seeking to correlate soil fertility, plant growth, and the distribution of deer populations in the area under study. Wide differences in nutrient response in the greenhouse were noted between soils.

Greenhouse fertility tests on representative soils from Tehama and Glenn Counties were completed, and the results written for inclusion in the comprehensive report of the County Surveys. Deficiencies of nitrogen, phosphorus, and sulfur occurred in that order. A small number of soils were found to be deficient in molybdenum.

Twenty-nine soils from the Fresno-Sierra soil-vegetation project were tested for fertility in the greenhouse. Deficiencies of nitrogen, phosphorus, and sulfur were found. Some of the more acid soils also indicated a need for lime and molybdenum.

Ten soils and two sub-soils of the Newville series were collected from Tehama and Glenn Counties. The areas were selected for suitability as sites for field plots. The object was to establish fertility pattern characteristic of the soil series and to compare the greenhouse results with those in the field. Previous tests on two soils of the Newville series had established nitrogen, phosphorus, sulfur and molybdenum deficiencies, using tomato as an indicator plant.

Group A: Analytical work on lima bean petioles established a critical acid soluble phosphate level at 500-700 ppm. Inbred lines of sugar beets revealed individual nitrogen and sucrose characteristics.

Group B: On slightly alkaline Metz soil, retardation of lettuce growth upon addition of  $\text{NH}_4$ -containing fertilizers could be corrected quantitatively with formation of nitrites in the soil.



Title: RANGE PLANT NUTRITION, RANGE SOILS AND RANGE FERTILIZATION  
(1959 - page 16)

Leaders: M. B. Jones, W. A. Williams, C. M. McKell, A. D. Haig, B. Kay  
and C. F. Walker

Progress: The sulfate S content of sub clover did not change as the plant matured from the one flowering stage to the five flowering stage in the greenhouse. As the amount of S applied to the soil was increased, sulfate accumulated faster in the stems than in the petioles or leaves. In spite of this, the critical sulfate value in each plant part appeared to be about 100 ppm. This same value has been tentatively confirmed by limited field work. One field study indicated that 20 pounds per acre S applied as gypsum increased the yield on a sub clover plot 75%, and 40 pounds S increased the yield 100%. Eighty pounds of S also increased the yield about 100 per cent. Greenhouse studies indicated that the acetic acid soluble phosphate content of sub clover decreased as the plant matured from the two to the six flowering stage. There was also a difference in the phosphate content of stems, petioles and leaves. Critical phosphate content of the different plant parts was determined. In a soil temperature experiment N fertilizer was more efficient in producing increased winter growth at 800 feet where the mean temperatures were 43 to 49° F. than where they were 30 to 42° F. at 3000 feet in elevation. Other studies during the year included work on molybdenum applied to Newville soils, N fertilization as it affects medusahead palatability, and the effects of fertilization on root development of annual range plants.

Title: CONTROL OF RANGE WEEDS, BRUSH, AND PLANT COMPETITION BY FIRE,  
CHEMICAL, MECHANICAL, GRAZING AND OTHER MEANS (1959 - page 19)

Leaders: B. L. Kay, C. M. McKell and O. Leonard

Progress: Flournoy Ranch - Modoc County. Grazing trials on 449 acres of wheatgrass (Agropyron sp) and 469 acres of cheatgrass (Bromus tectorum) were compared. Grazing in the wheatgrass pasture started two weeks earlier and produced four times as much beef per acre as the cheatgrass pasture. Rainfall was 7.56 inches (38 year average = 12.5 inches).

Pre-emergence herbicides were used to increase yields of rose and subterranean clovers and stands of hardinggrass in new seedings by reducing competing annual weeds. This is the third year of such trials. Yields of rose clover were tripled by the use of six pounds of eptam. Cheatgrass was removed from perennial wheatgrass with eptam without damage to the wheatgrass.

Tolerance studies of 2,4-DB on annual clovers show that rose, sub, and crimson clovers are not affected by moderate rates at early growth stages - the same growth stages when the material would normally be applied for weed control. Two pounds of the amine of 2,4-DB significantly increased the yield of crimson clover in 6-10 leaf stage. (Only three-fourths of a pound is recommended to kill weeds at this date.)

Similar studies with Dalapon showed the clovers were not tolerant at the rates popularly recommended for weed control. New experiments showed that lower rates of Dalapon may have a place in reducing medusahead for establishment of annual clovers.

Title: ECONOMIC USE AND INTEGRATION OF PASTURE AND DRYLAND RANGE FOR BEEF CATTLE PRODUCTION IN CALIFORNIA

Leaders: W. Gordon Kearl, D. D. Caton and C. O. McCorkle, Jr.

Objectives: 1. To describe the organization and operations of typical cattle ranches in California.

2. To determine the problems ranchers have in providing a feed supply commensurate with the type of operation they desire to maintain.

3. To determine the costs and returns of providing feed by different methods in different time periods.

4. To evaluate the productivity of the resources used by ranchers in supplying alternative feeds in different time periods as a guide to selection among reorganization opportunities.

Progress: This project was reoriented toward completion of a needed analysis of the organization and structure of the beef industry in California with emphasis on the role of range. Census data and ranch survey information have provided the basic data from which the analysis has been completed.

The analysis centers on the economic characteristics of beef cattle ranching in California, including geographic concentration, specialization, and location and the components of the domestically produced beef supply by source. The contribution of the ranges is emphasized. The possibilities for expanding the range production component are yet to be considered.

This project is providing a basis for evaluating future needs in range research of an economic nature. It will be particularly useful to the various elements engaged in production and distribution of meats in planning their future activities.

Title: MECHANICAL METHODS OF CONTROLLING POCKET GOPHERS

Leaders: R. A. Kepner, Agricultural Engineering, W. E. Howard and E. M. Brock, Field Stations, and M. W. Cummings, Extension Vertebrate Pest Control Specialist

Objective: To develop the most efficient type of mechanical gopher bait applicator that can be pulled by a wheeled tractor.



Progress: Detailed construction plans of the mechanical gopher-bait applicator were completed and made available to the public early in April and revised in December. A shear bolt just below the upper hitch point on the tool frame protects against possible damage to the shank and frame if the shank strikes an obstruction or if the steady pull becomes excessive. Two minor improvements were made in the shank - one to decrease burrow cave-in immediately behind the shank and the other to provide a steeper slope for the lower part of the bait deflector. The effectiveness of burrows 2-7/8" wide instead of 2-1/8" is being tested.

Operating instructions were made available in March and revised in May and again in December. A total of 30 field trials were conducted in nine counties in cooperation with farm advisors, county agricultural commissioners, and farmers. Results are favorable. Using grain baits treated with three per cent strychnine or 0.125 per cent 1080, about 70 to 75 per cent control is achieved. This is comparable to that obtained by hand treatment using cut carrots and strychnine, but the machine requires only a small fraction of the amount of labor that is required by the hand method. Three heavily infested plots in alfalfa were re-treated with the machine after two weeks and achieved an over-all control of 86, 87, and 89 per cent, respectively. Apparently, the reason grain baits have not been very successful in controlling gophers in alfalfa in California is because they carried an insufficient amount (usually 0.25% instead of 3.0%) of strychnine.

Title: INFLUENCE OF ENVIRONMENTAL FACTORS AND STRESSES UPON PHYSIOLOGICAL RESPONSE, GROWTH, AND PHENOLOGICAL BEHAVIOR OF FORAGE, RANGE, AND BRUSH SPECIES (1959 - page 12)

Leaders: H. M. Laude and C. M. McKell, Agricultural Research Service

Progress: Seasonal environmental fluctuations alter the values for root starch and twig moisture in chamise, but these features still indicate sprouting potential (Laude).

Fresh-seed dormancy can be induced in Bromus rubens by heat stress of the mother plant in the 2- to 3-leaf stage (Laude).

Head height and number of spikelets per inflorescence are valid indicators of range plant vigor under grazing (Laude).

Moisture stress decreases the absorption and translocation of foliar-applied phosphorus (McKell).

Availability of sulfur is greater from gypsum than from the elemental form during the first year after application (McKell).

Title: THE ANATOMICAL AND PHYSIOLOGICAL RESPONSES OF WOODY SPECIES TO  
HERBICIDES - A PROGRAM OF BRUSH CONTROL FOR CALIFORNIA  
(1959 - page 13)

Leaders: O. A. Leonard and A. S. Crafts

Progress: The absorption and translocation of an ester and an acid form of  $C_{14}$  labeled 2,4,5-T were studied in gorse and broom seedlings. Very little movement occurred with either form when applied to the leaves, except when the atmosphere was near saturation. Stem application with the ester was superior to any leaf application and was far superior to acid application to stems; however, the use of oil greatly increased the uptake of the acid by the stems.

Both 2,4-D and amitrol ( $C_{14}$  labeled) moved apically if applied when the grape plant was in flower, but these same compounds were also retranslocated. Some of the 2,4-D could be recovered from the fruit at harvest. The ready translocation of 2,4-D in the shoot was in contrast to the absence of translocation when applied to the roots.

White fir having stems infected with the dwarf mistletoe was fed with  $C_{14}$  labeled  $CO_2$ . The endophytic system was found to be a "sink" for the translocated labeled compounds in August and November, while the aerial system was a strong "sink" only in August (supported by NSF).

Title: NUTRITIVE VALUE OF SPECIFIC RANGE FORAGE SPECIES AS INFLUENCED BY  
SEASONS, FERTILIZATION AND MANAGEMENT (W-34) (1959 - page 13)

Leaders: G. P. Lofgreen, F. D. Carroll, W. C. Weir, R. M. Love, D. T. Torell  
and K. A. Wagnon

Progress: Continued work on the moisture content of grazed forage using the tritium dilution technique shows that the amount of saliva in the grazed sample increases as the moisture content of the forage decreases.

A new type of esophageal fistula plug has been developed which shows promise of improving this technique of collecting grazed samples.

Studies on medusahead show that sheep will graze this grass in proportion to its concentration in the stand until heading out when it is selected in a much lower proportion than its appearance in the stand.

Studies on rose and subterranean clover plots have shown that the DCP content of the forage will be adequate over the entire season whereas the TDN will become deficient in about June on regrazed plots and August on ungrazed areas.



Title: THE RELATIONS OF WILDLIFE TO AGRICULTURE

Leader: W. M. Longhurst

Objectives: To determine (1) parasite interrelationships of domestic sheep and deer, (2) food habits and range competition of domestic sheep and deer, (3) ecology of deer, and (4) management of deer on a livestock range.

Progress: A total of 58 deer were trapped during the summer. Of these 34 had been previously caught and tagged, 17 in previous years and 17 earlier in the present trapping season. Sight records of marked deer totaled 193 through the year.

Dental impressions were again taken of all adult deer handled to add to the fund of information on tooth replacement and wear for ageing purposes.

Thirty-four deer were autopsied during the year, and data was gathered on reproduction, growth, physiology, diseases and parasites.

Three counts were made during April, July, and October; and a total of 765 deer were classified. By determining the proportion of tagged and untagged deer in the herd, an estimate of total numbers was made which indicated that there were about 900 deer on the Station.

During the year 39 carcasses were found on the range. Data on age, sex, time and cause of death was collected. Since 1951 a total of 583 carcasses have been examined of deer dying on the range from natural causes.

Monthly counts of fecal pellet groups were continued in experimental pasture S-1 in an effort to evaluate the pellet counting technique on a known area with a known number of deer. However, results to date are so variable that further work appears necessary before final evaluation can be made. Two counts were made in the Watershed II area. They indicated a reduction in deer use of this area as compared to previous years.

Hunting effort on the Station during the regular deer season totaled 528 hunter days. Fifty-seven bucks were taken and 17 more crippled and lost. Weights and antler development of bucks exceeded those of the past few years.

Eighteen fawns less than a week old were caught and bottle raised. Data on growth rates was gathered. A two-year-old buck which had also been bottle raised and had been on full feed all his life weighed 202 pounds at the start of the rut, but lost 45 pounds during the rut. Range bucks of similar age average 90 pounds.

Measurements of deer consumption of unfertilized and fertilized grass over the winter period were again made. Results showed that unfertilized grass was taken at the rate of 126 pounds per acre and fertilized grass at 827 pounds per acre.

Survival of fawns to one year of age for the years 1956-59 compared to the number of adult does totaled 18.2 per cent in the S-1 pasture where deer were kept alone, and 36.8 per cent in the S-2 pasture where deer were kept together with sheep.

Although acorns of nine species of oaks and leaves of three species were analyzed for various nutrient constituents, no consistent pattern of correlation could be observed with the preference than penned deer showed for them.

A total of 136 hares were autopsied during the year; and data on food habits, reproduction, disease, parasites, growth and physiology were collected. The growth rate of a young captive hare is being studied.

A preliminary survey for serological evidence of Q fever showed positive titers for complement fixations in jack rabbits, deer, sheep, cows, and turkey vultures. Blood samples from horses, red-tailed hawk, bobcat, and raccoon were negative. Isolations from amniotic fluids of deer and raccoons were negative as were isolations from spleens of ground squirrel and gray squirrel. All blood samples proved negative when tested for Sporadic Bovine Encephalomyelitis. Similar tests for Nocardia asteroides showed positives for four deer and two jack rabbits.

Crowding of up to 14 deer in a 6-acre pasture over the winter of 1959-60 produced no measurable evidence of stress in terms of weight, reproduction or physiology.

Title: CYTOGENETICS OF RANGE SPECIES, AND THEIR IMPROVEMENT BY SELECTION AND BREEDING

Leaders: R. M. Love and W. E. Moon

Objectives: 1. To develop improved range types for dryland pastures, range-lands, and wildlands and watershed areas.

2. To conduct cytogenetic studies to obtain fundamental information.

Progress: Of special interest is the acquisition of 48 new genera, species, or varieties of forage grasses and legumes collected by the project leader in Spain during the spring of 1960.

The non-shattering mutant (T.O. 1883) of Ehrharta calycina (veldtgrass) progenies of polycross clones has been seeded for seed and forage yield trials.

Sufficient seed of Bromus mollis (T.O. 2549) is available for comparative plantings for controlled grazing by sheep on two soil types.

A natural crossing block of several Stipa species is under establishment at the Hopland Field Station.



Title: CONTROL OF HERBACEOUS RANGE WEEDS

Leader: Jack Major

Objective: To learn how to control herbaceous range weeds in the areas they now occupy, how to prevent their further spread, and what environmental factors and their combinations determine the actual and potential areas of distribution and the noxious qualities of herbaceous range weeds.

Progress: The results of my 1959 Mediterranean trip to locate several California weeds in their native habitat and to study their ecology were written up as reports to the Department of Biological Control at Berkeley.

Mr. J. P. Robison in a M. S. thesis in Range Management used medusahead seed from 13 localities in California, Oregon, Washington, and Idaho collected by C. M. McKell of ARS to investigate the presence of variation in this annual weedy grass which was first found in North America in 1887 near Roseburg, Oregon. Significant differences in % germination, speed of germination, rate of root growth, plant heights, and phenology were found on growing the plants in a uniform garden at Davis. The difference in flower emergence was 36 days, decreasing to a difference of 15 days for time of seed maturity. From this comparison of medusahead responses under uniform garden condition, we conclude that different ecotypes have been evolved in some 80 years in populations of this plant on western rangelands.

Title: ECONOMIC ANALYSIS OF ADJUSTMENT OPPORTUNITIES IN RANCH MANAGEMENT ASSOCIATED WITH RANGE AND PASTURE IMPROVEMENT (W-16)  
(1959 - page 16)

Leaders: C. O. McCorkle, Jr., Lynn Rader and Charles Carpy

Progress: A subproject under W-16 on the role of range improvement in Sierra-Nevada foothill cattle ranching is nearing completion. Several types of improvements on different ranch sizes and livestock systems are being considered. This research will be concluded by February or March and will be reported initially as a Ph. D. dissertation. Little revision will be required before it can be published for general distribution.

Two other pieces of work are completed and are to be written up during the coming year. These are: (1) costs and methods of fireline construction, and (2) costs and methods of improving California's brush land ranges.

During 1960 the emphasis in research under W-16 definitely shifted toward the second objective of the regional project - the impact of range improvement on ranch operation and income. In each piece of work, emphasis was placed on the effects of new and existing management and improvement practices and programs on organization and net returns of private ranch operations.

An analysis is in process on methods and costs of removing trees on oak and mixed woodland types. This analysis is based on time trials using time and motion techniques in study of tree removal on extensive areas of varying density of cover. All data has been assembled, and analysis is partly completed.

Title: POPULATION DYNAMICS OF RANGELAND GRASSHOPPERS (W-37)  
(1959 - page 14)

Leaders: W. W. Middlekauff, Department of Entomology, and Fred Proshold

Progress: As predicted in last year's report, the grasshopper population in 1960 showed a spotty but decided increase. On the basis of this year's observations, next year will show a more uniform and still greater increase. There will be localized outbreaks requiring chemical control.

Melanoplus devastator began hatching in the Mission Peak area during the first week of April. A light rain on May 2 caused a most spectacular late hatch by May 4. Most of the young nymphs had moved downhill, off the egg beds by June 13, and by early July adults and nymphs were strongly moving down slope. A few adults remained in the egg bed area, mostly males. Copulating adults were noted on September 14 in the absence of rain. Prior to this date, males had outnumbered females. From the second to third weeks in September, a strong movement of females back to the egg bed area reversed this ratio.

Title: THE RESPONSE OF RANGE PLANTS AND ANIMALS TO VARIOUS TYPES OF GRAZING AND MANAGEMENT SYSTEMS (1959 - page 21)

Leaders: A. H. Murphy, R. M. Love, J. E. Street, M. B. Jones, B. L. Kay and C. F. Walker. Cooperating with C. O. McCorkle and D. T. Torell

Progress: 1. Effect of Time and Intensity of Sheep Use on Unimproved Range. The first year of grazing indicated that stocking rate was too low as much feed was left at conclusion of grazing season. Gains per animal during the first grazing period were not similar even though feed production was comparable. During the heavy use period (March and April) the increase rate factors of 1-1/2, 2, 3 are not large enough to show differences. Stocking rates were increased during second grazing season.

2. Pasture Improvement by Use of Seeding, EPTC and Grazing. A second pasture was treated with 80 lb. per acre of 5% granular EPTC, then seeded to annual clovers and harding. Annual grasses were reduced while annual clover and forbs were increased over control treatment. Where three rates were used in 1958, the second year observation showed a carryover effect on reduction of annual grasses and increase of forbs; but annual legumes were less abundant on treated plots.



3. Forage Production and Composition on Hopland Field Station Range. Average forage yield from seven pastures was 1,746 pounds per acre (dry wt.) which compares with a 9-year average of 1,773 pounds per acre. Composition indicated annual grasses less abundant while Erodium, native legumes, and other forbs were more abundant than average.

4. Comparative Yield of Range Mixtures. The concluding year of this study showed that during the four years of yield data legumes alone were most productive (double the resident annuals except during the final year). Following in productivity were annual grasses plus legumes, then harding and legumes while lowest production was on resident annuals.

Title: GRASSLAND ASPECTS OF THE SOIL-VEGETATION SURVEY (1959 - page 20)

Leader: W. Robert Powell

Progress: 1. Grassland Vegetation Inventory. Inventory of herbaceous vegetation continues for Humboldt and Shasta Counties.

2. Greenhouse Nutrient Tests. Eight samples were run, but the data were lost. It was recalled that one sample of Josephine soil from Humboldt County was extremely deficient in P and N; P was needed before N was effective.

3. Field Nutrient Plots. Yields on two Sehorn plots in Shasta County were increased by N, P, and S. The north-facing plot was chiefly a study of grass species change. The south-facing plot had more forbs including Medicago hispida; forbs were prominent even on some of the nitrogen treatments. Difference in species composition between the two plots may be due partly to a litter build-up on the north plot.

A Sehorn plot on a north slope in Glenn County showed a response to N and S. There was no Medicago hispida on the plot. S gave a good green color to Avena fatua that was stimulated by N.

After three years, S has maintained a good composition of grass and Medicago hispida on another Sehorn plot in Glenn County. P stimulates the yield.

Title: DENSITY AND DISPERSAL CHARACTERISTICS IN POCKET GOPHER POPULATIONS

Leader: R. L. Rudd

Objectives: 1. To determine the relationships between reproductive success, mortality rate and population density in pocket gopher populations.

2. To study the movements of gophers, more particularly their permanent emigration or dispersal.

Progress: The major work under this project title in 1960 centered on supplemental collections of field specimens. The physiology and anatomy of the pocket gopher are very poorly known. Sufficient data is now available to caution that conclusions from laboratory rodents cannot be automatically transferred to field rodents. Obvious as such a precaution might seem, nonetheless such transfers are frequently made.

Collections at the Pomponio Ranch in San Mateo County were especially important to the analysis. Eight days were spent on the ranch during the year. Three seasons of the year were represented in the visits. It had been concluded by other observers that a major decline in numbers had occurred. In fact, decline, if it occurred at all, was slight and masked by a change in the behavior of the population. Certainly, reduced digging and surface activity characterized the affected population. Late summer and early fall samples indicated high densities still present on the ranch. However, individual gophers were in poor physical condition. Three indicators of this are: (1) heavy infestations of biting lice, (2) no body or mesenteric fat on many individuals, and (3) on all, petechiae on liver and spleen.

The following table shows body and adrenal weight comparisons between pocket gophers taken at Pomponio Ranch in late 1960 and in earlier winters. A "local" (i.e., Davis) sample is given to provide comparisons with a geographically, racially and environmentally different population. Inspection of the table reveals that only the figure for 1960 males from Pomponio Ranch is unexpected; it is quite high.

Body and adrenal gland weights of winter-taken specimens from the Pomponio Ranch (San Mateo Co.) with a comparison with winter-taken Davis specimens.

|                                  | <u>Body Weight (gr.)</u> |             | <u>Adrenal Weight (mg.)</u> |           |
|----------------------------------|--------------------------|-------------|-----------------------------|-----------|
|                                  | <u>M</u>                 | Range       | <u>M</u>                    | Range     |
| <u>Thomomys</u> - Pomponio Ranch |                          |             |                             |           |
| Winter 1960                      |                          |             |                             |           |
| Female (10)                      | 132.6                    | 114.1-163.1 | 14.77                       | 14.1-15.9 |
| Male (5)                         | 233.2                    | 151.8-327.5 | 18.10                       | 9.6-25.1  |
| Previous winters                 |                          |             |                             |           |
| Female (6)                       | 130.6                    | 88.2-169.8  | 18.20                       | 11.4-25.3 |
| Male (6)                         | 236.0                    | 197.0-294.0 | 12.01                       | 10.2-16.1 |
| <u>Thomomys</u> - "Local"        |                          |             |                             |           |
| Female (10)                      | 139.25                   | 97.0-169.0  | 12.46                       | 6.5-16.9  |
| Male (10)                        | 192.45                   | 104.0-239.0 | 9.13                        | 5.9-12.1  |

Additional field collections to be made this winter and spring are intended to supplement and add depth to existing data. When gaps in the data are filled, meaningful summaries and comparisons can be made.



Title: THE BIOLOGY, ECOLOGY, AND UTILIZATION OF CALIFORNIA BROWSE PLANTS

Leaders: A. W. Sampson and B. S. Jespersen

Progress: Only a few brief headings were added this year to round out the report better. The popular key to genera and species was completed and tried out under field conditions. The illustrations have not yet been assembled or described, but the report should be ready for submittal for publication in the spring or early summer of this year.

Title: IMPROVEMENT OF GRASS SEED PRODUCTION

Leader: D. C. Sumner

Objectives: 1. The evaluation of native and introduced species and improved varieties of grasses as seed crops for California.

2. To investigate agronomic practices that will improve seed production methods of native and introduced grasses.

3. To study the effects of agricultural practices upon seed quality, seed damage, and seed viability.

4. To study the problem of delayed seed germination, found in some grass species, in order to obtain more accurately the potential germinability in a shorter period of time.

Progress: Seed production of Russian Wild Rye and Intermediate Wheatgrass is dependent upon some unknown factors other than soil fertility. For two crop years at different locations there has been no significant response to seed yield from fertilizer trials.

At variance with published recommendations, seed production of sideoats grama responds to high levels of nitrogen fertilization. In addition to more tiller and seed being produced, subsequent lodging protects the maturing seed units from shattering.

Studies of harvest date vs. seed yield and shatter loss using Merion Bluegrass, Orchardgrass and Hardinggrass demonstrate the importance of harvesting these crops at the proper stage of field maturity to obtain highest seed yields with less shatter loss. The results also demonstrate conditions or stages of maturity at which harvest should be made.

Title: MANAGEMENT, MANIPULATION AND MEASUREMENT OF VEGETATION ON WATERSHEDS

Leaders: C. F. Walker and R. M. Love

Objectives: 1. To relate precipitation disposal and soil stability to vegetation and vegetation management in various wildland areas.

2. To measure and describe vegetation before, during, and after manipulation, thus enabling clarity in interpretation of the hydrologic effects of changes in the vegetation.

3. To procure through cooperation with the Department of Soils and Plant Nutrition a comprehensive description of the soils and vegetation associated with various phenomena of water yield and soil stability.

4. To measure and compare various characteristics of the vegetation with hydrologic characteristics of the watershed.

Progress: A watershed stream under calibration for the past seven years was usually dry by mid-July at the latest date and by mid-April at the earliest. After tree treatment the stream-flow was continuous through the summer and fall months and is still flowing.

A grazing yield of 203 sheep-days per acre was realized from a converted woodland watershed that was seeded to selected improved forage species after a control burn.

Based on a 4-year forage inventory of nine seeded perennial grasses, Harding and Smilo were the only species that indicated significant increases in the total ground cover percentage.

Drilling favored the establishment of Harding and broadcasting favored Smilo establishment where both were included in pasture development following a control burn.

The importance of including a desirable annual grass species with initial seeding is illustrated from a 6-year forage inventory of two comparable watershed pastures.

Single clipping indicates a threefold increase in total production over repeated clipping of hardinggrass. However, total protein production per acre was quite similar.



Title: THE ECONOMICS OF CONSERVATION

Leader: S. V. Wantrup

Objectives: 1. To study the basic and applied aspects of evaluating the "products" from uses of natural resources.

2. To study the economic interrelations between different uses of natural resources in connection with important management practices.

3. To study present and proposed public policies affecting uses of natural resources with particular emphasis on use interrelations.

Progress: 1. Natural Resources and Economic Growth. A research conference under this title was held in April at the University of Michigan under the joint sponsorship of the Committee on Economic Growth of the Social Science Research Council and Resources for the Future. Work for this conference involved critical review of 13 major papers and their discussion at the conference.

2. Conservation and Resource Programming. A paper under this title was invited for a symposium, "Programming the Use of Natural Resources," by Section E (Geography and Geology) of the American Association for the Advancement of Science. The assignment was to appraise the potentialities and limitations of certain mathematical tools in the economics of natural resources. This paper was presented at the Annual Meeting of the American Association for the Advancement of Science in New York on December 30, 1960.

3. Multiple Use as a Concept for Water and Range Policy. This study was undertaken as basis for the opening paper invited for the joint meeting of the Western Agricultural Economic Research Council and Council Committees on "Economics of Range Use and Development" and "Economics of Water Resource Development," January 23 and 24, 1961, at Tucson, Arizona. The study deals with the meaning of the concept "multiple use" in the economic theory of resource allocation and with the operational application of the concept as a part of allocative systems in public policy.

4. Water Policy. A contribution under this title was invited for the comprehensive Handbook of Applied Hydrology which is planned as a part of the well-known professional Handbook Series of the McGraw-Hill Book Co. More than 30 authorities are contributors. "Water Policy" will constitute the concluding Section of the Handbook. Work on this phase was interrupted because of other duties. Completion is expected during the first half of 1961.

Title: MINIMUM NUTRITIVE REQUIREMENT OF LIVESTOCK. PART B. SHEEP.  
(SURVEY OF RESPONSE OF SHEEP UNDER CALIFORNIA CONDITIONS TO A  
COBALT SUPPLEMENT)

Leaders: W. C. Weir; D. T. Torell; Monte Bell, Glenn County Farm Advisor;  
Lin Maxwell, Tehama County Farm Advisor; and Roderick Shippey,  
Mendocino County Farm Advisor

Progress: Mr. Bell conducted a trial with Randall Finch in Glenn County from March 3 to April 23, 1959 with 58 lambs. Every other lamb received a cobalt bullet. There was no significant difference in the gains of the treated and untreated lambs.

In a second test cooperating with Glen Eidman and Ken Sexton, Mr. Bell used 101 ewe lambs which were divided into control and treated by giving a bullet to every other lamb on July 10, 1959. The lambs were weighed again individually on March 21, 1960. There was no difference in weight change between the treated and untreated groups.

Mr. Maxwell conducted a trial with Sutfin Brothers in Tehama County. Fifteen wether and 15 ewe lambs were treated and a like number kept as controls. The test ran for 70 days from March 7 to May 17, 1959. The cobalt bullets did not significantly affect the gains of either the ewe or wether lambs.

Mr. Shippey of Mendocino County conducted two tests, but the results are not yet analyzed. When they are completed, it is intended to summarize all tests and publish a short article in California Agriculture.

All tests to date have shown no advantage from the use of the cobalt bullets under California conditions.

#### COLORADO

Title: THE VALUE OF NATIVE AND SEEDED RANGE GRASSES AND SUPPLEMENTATION  
REQUIRED IN THE NUTRITION OF BEEF CATTLE (W-34)

Leaders: F. C. Daugherty and Alfred Denham, Animal Investigations Section.  
Cooperating with Bill Dahl and D. F. Hervey, Forestry and Range  
Management Section

Objectives: 1. To study the nutritive value of native and seeded range  
grasses grazed in rotational pattern by beef cattle.

2. To investigate by chemical analysis seasonal changes in  
nutrient content of native and seeded range plants.

3. To determine nutrient losses from range cover to rodents,  
insects, weathering, and trampling by cattle.



4. To study the effect on beef production of protein supplementation regulated to balance seasonal nutrient variation in range grasses.

Progress: A 4-year phase of different supplements and supplemental feeding of producing cows was completed at weaning of the 1960 calf crop. The common range practice of winter high protein supplementation on native range, used as a control, was compared to: (1) winter supplementation with dehydrated alfalfa on native range, (2) late summer through winter supplementation with a high protein supplement on native range, (3) late summer through winter supplementation with dehydrated alfalfa on native range, and (4) winter supplementation on native range followed by rotational grazing during summer on seeded cool season grasses, seeded warm season grasses and native range. Statistical analysis shows significance (5%) for birth weights between lots, between cows of different ages and between sex of calves. Gain of calves from birth to weaning is significant (5%) between lots and for age of cows. Neither cow weights nor age of calves as related to daily gain showed significant differences by lots. Ocular observations show that tall grasses are used mostly in summer and short grasses mostly in fall and winter. Blood values of cattle showed little difference except for higher carotene and Vitamin A in winter for those receiving supplements of dehydrated alfalfa. Grass consumption by season tends to follow crude protein and crude fiber content of the grasses, but abundance of forage is a stronger determinant of consumption.

All methods of supplementation gave greater weaned calf return than the control, but only the rotational grazed lot and the lot receiving winter only supplement of dehydrated alfalfa showed an economic return.

Correlation analysis of the degree of forage utilization by livestock with the jack rabbit density indicated a higher density of jack rabbits on heavier grazed areas. Multiple regression studies indicate that degree of forage utilization, abundance of sand reed grasses and average height of vegetation accounts for 20.7 per cent of the variation in jack rabbit density. Studies have shown a lack of agreement between various methods of determining forage utilization by jack rabbits, and indicate a need for more intensive study of this problem.

A study is in progress to determine the loss of nutrients through weathering of forage plants on sandhill and sandy plains sites. The study includes the fluctuations and progressive loss of nutrients in growing as well as in mature plants, and the amount of forage lost through lodging before and after maturity.

Title: INDUCED VEGETATION OF DEPLETED RANGE AND ABANDONED CROPLANDS TO INCREASE CATTLE AND SHEEP YIELDS (1959 - page 23)

Leaders: A. C. Everson, Roy V. Miller, B. E. Dahl, Alfred Denham and Herbert Mann. Cooperating with Robert Bement, Agricultural Research Service

Progress: The asphalt emulsion-mulch study was expanded to four locations during 1960. Results were not as good as in the 1959 study; there is an indication that high temperatures occurring under the asphalt from the late June plantings of blue grama grass were detrimental to the germination process and offset the advantages gained through moisture retention under the asphalt-mulch. Earlier plantings are being made in the 1961 tests. At the Southeastern Colorado Branch Station, plots seeded in 1958 to a mixture of blue grama, sideoats grama, and western wheatgrass in annual weed and in sorghum stubble were sampled to determine the effect of mowing, spraying, or no control of weeds the year of sowing the mixture. Herbage yields of the seeded grasses were greater on the sprayed and check plots than on the mowed plots in the weed-cover seedbed; yields were greater on the sprayed than on the mowed or check plots in the sorghum-stubble seedbed. At this same Station, application of nitrogen or phosphorus at the time of seeding Russian wildrye was not beneficial as measured by forage yields in 1960 from plantings made 1957-1958. The plantings were made throughout the year and showed best results from those made February-May.

Title: COLORADO COOPERATIVE GOPHER PROJECT (1959 - page 23)

Leaders: R. M. Hansen and T. A. Vaughan. Cooperating with the U. S. Fish and Wildlife Service (Denver Laboratory) and the Rocky Mountain Forest and Range Experiment Station

Progress: A strychnine-milo bait was found to be as efficient at 2 lb/acre as at 4 lb/acre when used with the burrow-builder in eastern Colorado to control the Plains gopher. However, the strychnine-milo bait has not proven satisfactory for control of the Mountain and Valley pocket gophers. Preliminary data from food habit studies indicate that there may be an extensive overlap of food preferences between gophers and livestock on certain range types. Reproductive data on the Plains pocket gopher was obtained through the collection of 1,162 specimens. The single litter of young produced per year consisted of three to four young (average number of embryos per female was 3.58). Most of the pregnancies occurred during April, with the young being born in May and June. On Grand Mesa, trends in vegetation and pocket gophers were again determined on rangelands treated (and untreated) with 2,4-D. Gopher populations are still about 50 per cent lower on the sprayed areas than on the unsprayed. A similar study was begun to determine the effects of spraying sandhill range infested with sand sagebrush on the Plains pocket gopher numbers.



Title: FORAGE PRODUCTION AND SPECIES COMPOSITION OF SAND SAGEBRUSH RANGE AS AFFECTED BY CLIMATE, SOIL MOISTURE, AND INTENSITY OF GRAZING (W-25)

Leaders: D. F. Hervey and B. E. Dahl. Cooperating with F. C. Daugherty and Alfred Denham, Animal Investigations Section

Objectives: 1. To determine the effect of three intensities of grazing upon soil moisture conditions of sand sagebrush range.

2. To determine relationships between total precipitation, air temperatures, wind velocity, and soil moisture under three intensities of grazing.

3. To determine changes in plant cover as related to soil moisture and grazing intensity.

4. To determine trends in forage production as related to climate, soil moisture, grazing intensity, and changes in plant cover.

5. To determine weight gains of livestock under three intensities of grazing on sand sagebrush range.

Progress: The six pastures involved in this study were grazed by yearling steers during the period April 26 to September 27, 1961, which was the sixth year of the grazing treatments. Precipitation was 11.6 inches for the crop-year, the second lowest amount received in the six years. Both forage production and utilization were about the same in 1960 as in 1959, with the result that the heavy grazing treatments appeared to be over-grazing, and even the moderate grazing was a little heavier than planned.

For the first time in the six years of the study, the grazing treatments showed during 1960 a differential effect upon total forage production, with the greatest production under light grazing and the least under heavy grazing.

The pounds of beef gains per acre were: light grazing - 23.3; moderate grazing - 51.6; and heavy grazing - 58.9. If actual cost and return data for 1960 are used, the return per acre to the operator for his land, labor, and management would be -\$0.07 under light grazing; +\$0.77 under moderate grazing; and -\$3.38 under heavy grazing. Adverse market effects, combined with great costs under the heavy grazing system, account for the large loss of money per acre under heavy grazing, completely offsetting the advantage due to greatest number of pounds of beef produced per acre.

Collection of ecological data was continued during 1960, and as a result, significant predictive correlations were obtained between the relationship of depth of soil moisture about April 15 and the amount of forage produced the following summer.

Title: THE USE AND MANAGEMENT OF SEEDED RANGE UNITS (1959 - page 24)

Leaders: D. F. Hervey, B. E. Dahl and Roy V. Miller. Cooperating with F. C. Daugherty, Animal Investigations Section

Progress: At the Fort Collins Foothills Experimental Range, the six pastures seeded to a mixture of Russian wildrye and alfalfa were grazed by yearling beef cattle for the third successive year in the following grazing patterns: spring only, spring-fall, and summer. Line intercept transects established in 1958 were re-measured in 1960. Results showed Russian wildrye had increased under all grazing treatments while alfalfa had increased only in the pastures grazed in the spring only and had decreased under spring-fall and summer grazing; a corresponding decrease in the carrying capacity occurred in one of the spring-fall pastures.

At the Eastern Colorado Range Station the two pastures seeded to a mixture of intermediate wheatgrass and alfalfa, and the two pastures seeded to intermediate wheatgrass only were grazed by yearling beef cattle for the fifth consecutive year during the period of late April to mid-August. The grass-alfalfa pastures continued to yield nearly twice (1.9x) as much herbage per acre as the grass pastures; likewise they produced nearly twice (1.7x) as much beef gain per acre. Line intercept measurements in 1956 and 1959 show a greater increase of the intermediate wheatgrass in the mixture pastures than in the grass pastures; Rhizoma alfalfa increased more than Ladak or Sevelra.

Title: IMPROVING SAGEBRUSH LANDS TO OBTAIN MAXIMUM RANGE LIVESTOCK PRODUCTION (1959 - page 24)

Leaders: D. F. Hervey and Roy V. Miller. Cooperating with the Bureau of Land Management

Progress: Forage samples were taken again from the area set aside in 1956 to compare range improvement through: (1) deferment only of the depleted sagebrush range, (2) deferment plus mowing of the sagebrush, and (3) deferment with mowing and seeding to crested wheatgrass. The 1960 yields of grass, in pounds per acre of air-dry herbage, for each of the above treatments were: (1) 223; (2) 667; (3) 674.

A date-of-mowing study utilizing a split-plot with and without reseeding was established in 1960.

Pastures involved in the sagebrush-burning tests were grazed for the eighth consecutive year by yearling steers, and the herbicide-treated pasture was grazed-for the seventh consecutive year. The grazing intensity study on crested wheatgrass pastures was repeated for the sixth year, and the season-of-grazing was continued for the fifth year.

The grazing season was increased to 102 days in 1960 after the cut-back in 1959 to 84 days due to drought.



Average beef gains per acre on the various pastures were: untreated sagebrush range, 10.3; sagebrush burned and pasture reseeded, 28.7; sagebrush burned, 13.0; sagebrush treated with herbicides, 14.6.

In the season-of-grazing test, the season-long use of crested wheatgrass produced 24.8 pounds of beef per acre as compared to 29.2 pounds on the early-season use. The native sagebrush pasture grazed season-long produced 10.1 pounds of beef per acre while the late-summer grazing produced 6.3 pounds. The advantage from early-use of crested wheat was offset by the lesser gain made on the late-season use of native range.

The heavily grazed pasture yielded 42.8 pounds of beef per acre, and the moderately grazed pasture produced 22.7 pounds.

Title: WEEDS DETRIMENTAL TO LIVESTOCK AND AGRICULTURE

Leaders: Bruno Klinger, Department of Botany and Plant Pathology. Cooperating with D. F. Hervey, Forestry and Range Management Section; the U. S. Forest Service; and the Holy Cross Cattlemen's Association, Garfield County; and the Extension Service

Objectives: 1. To increase the effectiveness and practicability of controlling weeds under the wide range of environmental conditions and types of farming and ranching common to the State of Colorado through improving methods now in use, evaluating promising methods, and developing new methods through coordinated, fundamental field research.

2. To determine by means of properly conducted general and local field surveys, and other available means the location, extent and importance of those weeds and poisonous plants that constitute or threaten to constitute a serious problem in the State.

Progress: Readings made on Tall Larkspur Control plots treated in 1959 showed that both Silvex 2(2,4,5-Trichlorophenoxy) propionic acid and an amine of 2,4,5-Trichlorophenoxy acetic acid applied at heavy rates killed from 65 to 100 per cent of larkspur plants. Urea compounds applied in granular form killed from 75 to 88 per cent of Tall Larkspur.

Materials were applied at varied rates in 1960, to determine minimum amounts of herbicides required for satisfactory control of Larkspur. Results will be determined from 1961 plot readings.

Hand grubbing was used on Hypericum perforatum to determine whether small infestations of the weed can be completely eliminated.

Title: THE EFFECT OF FERTILIZERS ON THE SEASONAL TRENDS IN NUTRIENTS OF NATIVE AND RESEEDED FORAGE PLANTS IN RELATION TO RANGE LIVESTOCK PRODUCTION (1959 - page 25)

Leaders: Charles Terwilliger and Roy V. Miller. Cooperating with Lloyd Washburn, Animal Investigation Section

Progress: Plots which had been fertilized in 1958 and 1959 were grazed again by cows in 1960. Samples were taken to determine the carryover effect of the various nitrogen applications on palatability, forage production, crude protein content and seed yield.

Analysis of the results indicates that the carryover effects from both the 1958 and 1959 applications of nitrogen were not significant.

#### IDAHO

Title: THE VALUE OF IDAHO RANGES AND SUPPLEMENTATION REQUIRED IN THE NUTRITION OF BEEF CATTLE (W-34)

Leaders: J. P. Baker, T. D. Bell and T. B. Keith, Department of Animal Husbandry, and A. C. Wiese and D. J. LeTourneau, Department of Agricultural Chemistry

Objectives: 1. To improve techniques for measuring the qualitative and quantitative forage intake of range beef cattle and the digestibility of range forage.

2. To determine the protein and energy requirements of beef cattle compatible with optimum production on Idaho ranges.

Procedure: For the attainment of Objective 1, the following steps are planned:

a. Installation of rumen fistulas in a number of cattle which will later be used as forage samplers.

b. Determination of the degree of change in moisture content and analysis of forage samples to be expected in determining forage intake by the rumen evacuation technique of Lesperance et al., (1959). This will be repeated with different forages and with forages of different moisture content in an attempt to arrive at a suitable correction factor to be used for a particular type of forage.

c. The fistulated cattle will be used with intact cattle in grazing trials and the average forage quality consumed by all animals will be determined from the fistulated group.



d. The fistulated cattle and representative intact cattle will be utilized in external and internal indicator studies to determine digestibility and amount of forage intake. For the quality of forage consumed, use will be made of the information gained from step c (above).

The following steps are planned to provide information toward the attainment of Objective 2:

a. By use of the rumen fistulated cattle, the effects of supplemental feeds, varying in protein and energy content, on the following will be investigated:

- (1) Cellulose digestion by the nylon bag technique.
- (2) Forage sample digestion by the nylon bag technique.
- (3) Volatile fatty acid production.

Results of these studies will be related to animal performance wherever possible.

b. Gross measurements of the effects of supplemental feeding will be made (calf crop percentages, birth weights and weaning weights of calves, condition scores of the cows).

c. Studies will be made of the effects of various supplemental feeds on forage intake by the use of indicator methods.

Progress: This project has just been initiated and work is beginning. The first rumen fistula has been installed, and others will be installed shortly.

Title: STUDIES ON THE ECOLOGY AND PROPAGATION OF ST. JOHNSWORT INSECTS  
IN IDAHO (1959 - page 26)

Leaders: W. F. Barr, H. C. Manis and C. I. Seely. Cooperating with  
E. W. Tisdale

Progress: In the Clearwater River and Salmon River drainages the resurgence of St. Johnswort (Hypericum perforatum), growth was significantly curtailed by the leaf beetles Chrysolina gemellata and C. hyperici. Considerable beetle activity was found in all areas and even on isolated plants. Studies over the past several years have shown that marked fluctuations in St. Johnswort populations can be expected in the future. However, Chrysolina beetles will respond to increases in plant numbers and in two to three years time will effect control of the weed.

Title: INVESTIGATIONS OF HARVESTER ANTS ON IDAHO RANGE LANDS

Leaders: W. F. Barr, Department of Entomology, and L. A. Sharp, Forest, Wildlife and Range Experiment Station

Objective: To determine the effect of harvester ants on various range types and species, with emphasis on the relation of ant populations to range conditions.

Procedure: The number and size of harvester ant colonies have been determined on six adjacent 1-acre plots at each of three sites in the Raft River Valley, Cassia County, Idaho. Two of these sites are located in Atriplex nuttallii vegetation and one in an A. confertifolia community. One-half of the plots at each location have been treated with insecticides to control the ant colonies. The vegetation at each site has been sampled and continued observations of ant colonies and vegetation have been made.

Progress: The results of the first three years of this study indicate that: (1) harvester ants are an important factor on the two range types studied (shadscale and Nuttall saltsage); (2) within the saltsage type, the number and total area of bare areas produced by harvester ants were greater on depleted areas than on those in good range condition; (3) the actual area occupied by these "ant clearings" averaged 3.5 per cent on the good condition saltsage range and 5 to 8 per cent on poor condition areas within this type.

Title: THE LIFE HISTORY, ECOLOGY AND CONTROL OF INSECTS ASSOCIATED WITH THE INTERMOUNTAIN SHRUB TYPE IN SOUTHERN IDAHO (1959 - page 25)

Leaders: W. F. Barr, L. A. Sharp and E. W. Tisdale

Progress: Studies on the biology of the sagebrush defoliator, Aroga websteri Clarke, (Lepidoptera: (Gelechiidae), were continued with the results presented in an unpublished master's thesis. Aspects of this study will appear in several forthcoming publications. During this two-year study, more than 150 collections of the various life history stages of this moth were made, along with other types of field and laboratory studies. Detailed descriptions of the stages were also completed to aid in distinguishing the immature stages of this insect from the immature stages of other Lepidoptera found on sagebrush.

A preliminary study of the gall forming insects on several species of range plants was initiated. Numerous collections of galls were made throughout the rangeland areas in southern Idaho. The galls have been described along with the immature stages of some of the insects responsible for the formation of the galls or those insects which are involved secondarily with the gall. This study is handicapped to some extent due to the difficulty in getting the insects identified.



A study was initiated on the biology of the rabbitbrush defoliator in Idaho. Preliminary collections were made which have provided information on all the developmental stages of this insect. Additional information is being obtained on the distribution, host plants, and parasites of this insect. Initial studies on the use of artificial media for rearing this moth have been successful.

Studies have continued on the western harvester ant in saltsage and shadscale stands. It has been determined that the greatest damage by these insects takes place in depleted saltsage stands. In such stands, the ants are more abundant and clear more area than in good saltsage stands or good shadscale stands. There is a relationship between range condition and the presence and damage of this insect.

Survey type collections have been continued from most shrub species found on rangelands in southern Idaho. Preliminary work has begun on the presentation of the data obtained from these collections in the form of an annotated list of insects associated with rangeland plants.

Title:       STUDY OF MEDUSAHEAD ON IDAHO RANGES (1959 - page 28)

Leaders:    Minoru Hironaka and E. W. Tisdale

Progress: The return of perennial vegetation in a dense stand of medusahead is encouraging. In the Crane Creek exclosure, constructed in 1952 by the Bureau of Land Management, the perennial vegetation was so sparse that the locations of all perennial plants, excepting Poa secunda, were charted within 100 x 100' grids. In 1955 the exclosure was sampled with sixteen 50-foot lines and 4 x 50' belt transects from which basal cover and density of the perennial species were determined. The vegetation was again sampled in 1960. A summary of the data is presented in Table I.

Table I. Average Number of Plants per 200 Square Feet.

| <u>Species</u>                                    | <u>1955</u> | <u>1960</u> | <u>Difference</u> | <u>Significance<br/>at 5% point</u> |
|---|-------------|-------------|-------------------|-------------------------------------|
| Poa secunda                                       | 60.6        | 56.8        | - 3.8             | No                                  |
| Sitanion hystrix                                  | 9.5         | 18.5        | + 9.0             | Yes                                 |
| Other perennials (mostly<br>Agoseris glandiflora) | 4.6         | 55.8        | +51.2             | Yes                                 |

Average Line Intercept in Percent on 50-Foot Lines.

| <u>Species</u>   | <u>1955</u> | <u>1960</u> | <u>Difference</u> | <u>Significance<br/>at 5% point</u> |
|------------------|-------------|-------------|-------------------|-------------------------------------|
| Poa secunda      | 8.8         | 4.2         | - 4.6             | Yes                                 |
| Sitanion hystrix | 0.3         | 1.7         | + 1.4             | Yes                                 |

The basal area of Poa secunda was reduced during the past five years although the number of plants remained essentially the same. The Poa plants apparently reached their maximum development, and deterioration is now taking place. The plants have started to break up with development of dead centers.

The density of the other perennials continued to increase. This is notably true of Sitanion hystrix and Agoseris grandiflora. The increase in number of Agoseris has been phenomenal on one slope with an east aspect. On the average it increased from 9 to 192 plants per 200 square feet.

Several studies of growth development, competition, seed germination characteristics and soil moisture relations of medusahead and associated species were begun but have not progressed far enough to yield results.

Title: EVALUATION AND IMPROVEMENT OF SALT-DESERT SHRUB RANGES  
(1959 - page 30)

Leader: L. A. Sharp

Progress: Intact stands of perennial vegetation continue to maintain effective halogeton (Halogeton glomeratus) control. Depleted stands of salt-desert shrub vegetation remain principally occupied by halogeton.

Some improvement was noted in the vigor of winterfat (Eurotia lanata) plants in the vicinity of an area fenced in the fall of 1958 against livestock and rabbits. This area should provide information on the rate of recovery of a winterfat stand after severe grazing for a number of years.

Studies on the ecology of Indian ricegrass (Oryzopsis hymenoides), squirreltail (Sitanion hystrix), desert molly (Kochia americana), and shadscale (Atriplex confertifolia) were initiated in 1958 and continued in 1959. Individual mature plants of each species were marked for observations on growth and development. Seedlings of shadscale, saltsage (Atriplex nuttallii) and winterfat were also marked to obtain information on rate of growth and mortality. Germination characteristics of each species are being investigated in the laboratory and under field conditions. Root studies and transplant studies are also underway on a number of the native perennial species of the salt-desert shrub type of vegetation. Results will be presented in subsequent reports.

Title: EVALUATION OF RANGE RESEEDING ON SAGEBRUSH RANGES (1959 - page 30)

Leaders: L. A. Sharp. Cooperating with T. D. Bell

Progress: Unfavorable growing conditions during the spring trials of 1959 retarded growth and resulted in over-utilization of all three pastures. Gain per acre was nearly the same for all three pastures during this year.



During the late summer of 1959, all six pastures on the study area were sampled using the same procedure as used during the first year of the study to determine density and frequency of crested wheatgrass.

Table I. Number of Crested Wheatgrass Plants per Square Foot in 1955 and 1959.

| <u>Treatment</u> | <u>1955</u> | <u>1959</u> | <u>Difference</u> | <u>% Increase</u> |
|------------------|-------------|-------------|-------------------|-------------------|
| Spring           |             |             |                   |                   |
| Light use        | 1.31        | 2.33        | 1.02              | 77.9              |
| Moderate use     | 0.96        | 2.86        | 1.90              | 197.9             |
| Heavy use        | 1.01        | 2.61        | 1.60              | 158.4             |
| Fall             |             |             |                   |                   |
| Light use        | 1.36        | 2.67        | 1.31              | 96.3              |
| Moderate use     | 1.28        | 3.13        | 1.85              | 144.5             |
| Heavy use        | 0.97        | 3.10        | 2.13              | 219.6             |

Preliminary analysis shows the increase of crested wheatgrass plants to be highly significant on all pastures over the first five years. A marked increase in crested wheatgrass plants per square foot has occurred in all six pastures.

Crested wheatgrass has filled in the open spaces throughout the pastures to give a greater than 90 per cent frequency. It is difficult at this point to determine any influence of grazing intensity. A higher frequency in the fall pastures may result from greater seedling survival and establishment.

Differences in animal production by intensity of use have not shown up at the end of the first five years of this study. Yearly variations in cattle gains may be attributed directly to the amount and development of the crested wheatgrass forage. A statistical analysis of animal production by intensity and season of use has not been done at this early stage of the experiment; however, average daily gains tend to indicate a significant difference between seasons of use.

Title:       IMPROVEMENT OF INTERMEDIATE WHEATGRASS BY SELECTION AND RECOMBINATIONS

Leader:     A. E. Slinkard

Objective: To develop a strain of intermediate wheatgrass, Agropyron intermedium (Host) Beauv., which is more uniform in vegetative characteristics and higher in seed and forage production than the strains now in common use.

Progress: S. D. 20, Ree, Nebr. 50, Idaho 4 and A-12496 were the highest forage yielders in a 2-year test at Moscow. Plots grown in alternate rows with Ladak alfalfa or receiving an annual fall application of 50 pounds N outyielded plots receiving no nitrogen.

Second-year seed yields were low without N. Plots planted in 24" and 36" rows outyielded those planted in 12" rows. S. D. 20 and Amur were the highest seed yielders in a 2-year test. Amur, another high seed yielder, was inadvertently omitted from the nursery.

Eighty-four clones from the Clonal Nursery were established in a Topcross Yield Trial using topcross seed.

Forage and seed yields will aid in determining variety adaptations within the state. Intermediate wheatgrass for seed production should be grown in rows at least 24" apart with annual nitrogen fertilization. Information on general combining ability from the Topcross Yield Trial will provide a firm foundation for clonal selection.

Title: ECOTYPIC VARIATION IN IDAHO RANGE SPECIES (1959 - page 31)

Leader: E. W. Tisdale

Progress: Notes were taken throughout the year on growth development and characteristics of the material in the Festuca nursery at Moscow. Less detailed observations were recorded for the Stanford, California, nursery material by Dr. Nobs of the Carnegie Institution of Washington.

At Moscow, the general pattern was one of active leaf growth during the moist fall of 1959, followed by a high percentage of winter survival. The most severe winter loss (7%) was suffered by a Festuca idahoensis, a collection from high mountain grassland (7300 feet) in western Montana. Growth development in 1960 was accelerated by above normal temperatures in early April, with most plants reaching the sheath stage by the middle of that month. Flowering for most collections occurred in early June. Culm production was greater than normally observed in the field, giving most of the plants a "stemmy" appearance. Seed production was heavy in most lots. Vivipary was found in two plants of F. idahoensis from a shallow soil site near Roger's Pass, Montana.

At Stanford there was a much higher rate of vivipary and of mortality than at Moscow. Vivipary was particularly developed in all of the collections from Montana and one from McCall, a cool, high-elevation station in Idaho.

Marked variation was evident both among and within the F. idahoensis nursery populations. The characters involved included leaf coarseness, width and color; number, coarseness and erectness of culms; survival percentage; and amount of vivipary. Characters such as the predominance of "blue-green" foliage color and presence of "dwarf" plants in most of the Montana collections showed as clearly as in the previous year. Some of the features of the relatively small, fine-leaved plants from sagebrush-grass communities (Dubois, Squaw Butte, etc.) were obscured by the ranker growth and more abundant culm production of the nursery plants.



Title: ECOLOGY AND CONTROL OF GOATWEED (HYPERICUM PERFORATUM)  
(1959 - page 32)

Leaders: E. W. Tisdale and W. F. Barr

Progress: Since a complete re-study of all the principal sites was made in 1958, work during the current year was confined to re-sampling three sites and making periodic observations on two of them. The two sites selected for intensive study are located in the lower Clearwater drainage. These were re-sampled in July 1959 and at the end of June 1960. One of these (No. 1) belongs in the oldest group of study sites in Idaho, having Chrysolina beetles released on it in 1948, while the other site (No. 3) was established in 1951. Both were selected as representative Hypericum infestations on depleted areas in the Agropyron/Poa zone. The third site, located in a ponderosa pine planting in the Kaniksu National Forest, was re-sampled in September 1959 but not in 1960. At this site, the number and stature of Hypericum plants showed a sharp drop due to increased beetle activity.

At both sites 1 and 3 there was a definite increase in beetle activity and a marked decrease in number and stature of Hypericum plants from 1959 to 1960. At the oldest site, for example, the average number of live Hypericum plants per square meter declined from 15.2 to 2.5. In 1959 the plants were relatively vigorous, with little beetle damage evident and many were producing seed. At the same period in 1960 the few live plants remaining had the leaves and upper shoots heavily eaten by Chrysolina beetles, and no seed was being produced. A similar situation was found at the other intensively studied site.

These results indicate that attainment of a dynamic equilibrium between populations of Hypericum and the Chrysolina beetles may be near, but further work is needed to determine the limits within which fluctuations in the populations of each may occur.

Title: ECOLOGY OF SAGEBRUSH GRASS IN IDAHO WITH SPECIAL REFERENCE TO  
VEGETATION-SOIL RELATIONSHIPS (W-25) (1959 - page 33)

Leaders: E. W. Tisdale, M. A. Fosberg, Minoru Hironaka and G. C. Lewis

Progress: Sampling of relatively undisturbed sites in sagebrush vegetation was continued, bringing to 70 the total number of sites. In addition to the field studies, complete chemical characterization analyses have been completed on 33 of these sites.

An application of plotless sampling, the distance measure method, was used to sample two areas of partially depleted sagebrush vegetation as well as a sagebrush thinning experiment. The latter study was set up to measure the response of both herbaceous species and shrub species to the removal of various fractions of the sagebrush cover from a site of known classification.

Forage yield studies continued on two sites showed production slightly over double that harvested in 1959.



A start was made in cooperation with the Oregon W-25 group at programming the vegetational and soils data for processing by IBM equipment.

Title: A STUDY OF THE ECOLOGY AND CONTROL OF HALOGETON (1959 - page 34)

Leaders: Paul J. Torrell and L. C. Erickson

Progress: The most significant research results pertaining to halogeton control were concerned with studies to revegetate halogeton-infested ranges with saltsage, a desirable native forage species. Favorable results were achieved in an attempt to increase the germination of saltsage seed and to provide a means of obtaining a higher seed yield than is true of the native stands. Scarification of saltsage seed in combination with stratification gave 64 per cent germination as compared to 3 per cent germination of untreated seed samples. A fall planting of saltsage on irrigated land was successful. The species responded well to irrigation, and the prospects for good seed yields in the future are favorable.

Attempts to control halogeton with pre-emergence applications of the benzoic acid herbicides were continued. In a location study, two pounds of 2,3,6-TBA gave satisfactory halogeton control at three sites. But at two sites, four pounds of the same herbicide provided unsatisfactory control of the weed. In a test of new benzoic acid formulations, 2,3,6-trichlorophenyl-acetic acid was superior to 2,3,6-TBA in the first year following application of the herbicides. A date of application study showed better results from the application of 2,3,6-TBA in April of 1959 than in November of 1958.

There are now some 10.8 million acres of rangeland in eight western states infested with halogeton. A salt-tolerant species such as saltsage is needed to replace extensive halogeton stands. A means of controlling small stands of halogeton in new areas by herbicide is needed.

Title: THE CONTROL AND ERADICATION OF WEEDS ON PASTURE AND RANGE LANDS (1959 - page 34)

Leaders: Paul J. Torell, L. C. Erickson and C. I. Seely

Progress: Major emphasis has been on the medusahead (Elymus caput-medusae). Field work was conducted in Gem and Latah Counties and laboratory work at Parma and Moscow. Range burns on June 21 in Gem County resulted in almost total seed destruction. Germination equalled 0.2%, and these were weakened seedlings. Preparations were made for reseeding Medusahead-infested ranges by cultivation, chemicals and burning one year prior to the seeding operation. Chemical control showed that dalapon was most effective when applied from April 20 to May 4. Dilution rates varying from 5 to 40 gallons per acre were equally effective. All parts of the plant were analyzed for SiO<sub>2</sub> content. Six herbicides were applied on tall larkspur. Eight pounds per acre of 2,4,5-T proved most effective, resulting in only four pounds per acre regrowth the following year. Surveys in 1960 indicate that 1959 was probably the peak in the goatweed



(Hypericum) cycle with nearly 50 per cent as much goatweed as before biological control was started. Further progress was made in 1960 on control in the Rathdrum Prairie area.

Burning medusahead ranges may become a profitable practice if proper timing can be established. Likewise, proper timing of herbicide applications will aid in more efficient control. The heavy resurgence of goatweed in 1959 and 1960 indicates the necessity for improved range management in conjunction with biological control.

Title: EVALUATION OF FORAGE SPECIES AND SEEDBED PREPARATION OF SOUTHERN IDAHO DRY LAND PASTURES AND RANGES (1959 - page 35)

Leaders: Paul J. Torell, John Kolar and Alfred Slinkard

Progress: Nurseries to evaluate the performance of various forage grasses on the dryland ranges in southern Idaho were established at four locations in October of 1958. Two locations, the Raft River and the Bliss area, established measurable stands, while nurseries at Shoshone and Emmett were unsuccessful because of severe cheatgrass and medusahead competition. An evaluation of the grass stands at the Raft River and Bliss locations showed that only those entries that constitute species and/or varieties of the desert wheatgrass complex were able to maintain satisfactory stands in 1960.

Forty plants of saltsage, Atriplex nuttallii, that appeared superior in seed production, were selected. Large variations existed in maturity, fruit size, fertility and plant type.

Increased emphasis on range reseeding emphasized the importance of species adaptation under various dryland environments. Work has shown that the species of the crested wheatgrass complex are superior for establishing cover and providing forage on most dryland sites in Idaho.

## KANSAS

Title: THE EFFECTS OF DIFFERENT SYSTEMS OF MANAGEMENT OF GRASSLANDS AND CONSERVATION AREAS UPON THE INSECTS INJURIOUS TO GRASSES

Leaders: Herbert Knutson, Orlo K. Jantz, Gerald Greene and Darol L. Kaufmann, Department of Entomology; Kling L. Anderson, Department of Agronomy

Objectives: 1. To determine the cause and extent of insect injuries to grasslands.

2. To study the relationship between grassland insects and insect injuries to adjoining crops.

3. To study the life histories, habits and control of grassland pests.

Progress: Fifty species of Chrysomelid beetles collected during 1958 and 1959 in each of nine pasture treatments, each containing three soil types, were identified, their adult seasonal incidence determined, and their populations correlated with plant populations to some extent. Host plants were determined in some cases.

The seasonal histories of more than 30 species of grasshoppers, and the relative abundance of each, are being studied in the same pastures mentioned above for the Chrysomelid studies. The number of each species of plant within each pasture treatment and soil type has been obtained from the Department of Agronomy and data established to determine correlation between populations of various species of plants and species of grasshoppers.

Future Plans: Continue study of correlation of numbers of Chrysomelid species with numbers of plant species. Determine host plants for adults and larvae and types of damage done to hosts. Describe larvae. Probably initiate similar studies with the Scarab beetles. Conduct similar studies on Hemiptera and Homoptera, when qualified and interested personnel are obtained.

Continue grasshopper studies, determining actual host plants, and initiate behavior studies of various grasshopper species.

Title: EFFECTS OF SEEDING DATE, SEEDBED COVER TYPE, AND QUANTITY OF MULCHING MATERIAL ON SEEDLING ESTABLISHMENT OF NATIVE PERENNIAL GRASSES (1959 - page 41)

Leader: J. L. Launchbaugh

Progress: Cool-season species such as western wheatgrass (Agropyron smithii) emerged best from plantings made from November to April. Warm-season species emerged best from plantings made in April and May. Mid-summer plantings of warm-season species were successful on occasions following timely showers. Results from seeding at various times in different quantities of residue are indefinite, and further work will be done on this during 1961.

Title: EFFECTS OF COMMERCIAL FERTILIZERS ON RESEEDED GRASSES IN WEST-CENTRAL KANSAS (1959 - page 41)

Leader: J. L. Launchbaugh

Progress: Carryover effects from field applications of N, P, and NP during 1959 were measured on two sites in 1960. A low fertility site showed a significant response to carryover N and NP.

Future Plans: This study will be expanded in 1961 to include native range and to study dates and rates of N applications.



Title: EFFECTS OF VARIOUS MOWING AND BURNING TREATMENTS ON THE PRODUCTION OF NATIVE AND RESEEDED GRASSES (1959 - page 42)

Leader: J. L. Launchbaugh

Progress: Results in general indicate that yields of perennial grasses are less variable from year to year if the old residue is removed by mowing or burning than if allowed to accumulate. High accumulations of residue reduce tiller numbers. Yields remain low until most of the residue decomposes.

Title: THE EFFECTS OF CHEMICAL AND MECHANICAL WEED CONTROL ON NATIVE RANGE VEGETATION (1959 - page 43)

Leader: J. L. Launchbaugh

Progress: During 1960, all treatments reduced weed yields but did not increase grass production significantly on a clay upland site where buffalograss (Buchloe dactyloides) and blue grama (Bouteloua gracilis) were the major grasses. On a lowland site, weed control in a dense stand of western ragweed (Ambrosia psilostachya) and maretail (Conyza canadensis) doubled the grass yields where shortgrasses and midgrasses were growing together. It appeared that a denser stand of weeds and better soil moisture relations on the lowland site caused increases in grass production under weed control when compared with the upland site.

Title: EFFECTS OF THREE INTENSITIES OF SUMMER GRAZING ON NATIVE VEGETATION AND STEER GAINS (1959 - page 43)

Leaders: J. L. Launchbaugh and J. R. Brethour

Progress: Yearling steer gains during the summer of 1960 averaged 108, 120, and 117 pounds per head under heavy, moderate, and light grazing, respectively. The gains for moderate and light grazing were unusually low this season. Much of this was accounted for in that previous winter gains of the test animals were nearly 250 pounds per head. Forage yields were above average, but the mid- and late-summer quality was below average.

Future Plans: The 1961 trials will be conducted using yearling steers that are wintered on native range with a protein supplement in order to have stockers comparable with ones that normally are placed on summer range.

Title: EFFECTS OF THREE INTENSITIES OF WINTER AND SPRING GRAZING ON  
NATIVE VEGETATION AND STEER GAINS (1959 - page 44)

Leaders: J. L. Launchbaugh and J. R. Brethour

Progress: Results for 1960 are similar to those reported in 1959. It appears that supplementing winter range with grain in addition to protein is not economically feasible in terms of steer gains.

Future Plans: The steers will be wintered on range supplemented only with protein during the 1960-61 winter.

Title: COMPARISON OF COTTONSEED MEAL AND SORGHUM GRAIN AS SUMMER NATIVE  
PASTURE SUPPLEMENTS (1959 - page 45)

Leaders: J. L. Launchbaugh and J. R. Brethour

Progress: Sorghum grain fed at the rate of  $1\frac{1}{2}$  lb. per yearling steer continues to be as effective as  $1\frac{1}{2}$  lb. of cottonseed meal as a late summer supplement on native range.

Future Plans: Native forbs, western ragweed (Ambrosia psilostachya) in particular, have increased significantly since 1957 in the test pastures. Since protein analyses of ragweed indicate rather high percentages of crude protein during late summer and utilization checks show a high frequency of grazed ragweeds, protein supplement will be compared with no supplement on pastures containing large amounts of western ragweed.

Title: COMPARISON OF UPLAND RESEEDED WESTERN WHEATGRASS, SWITCHGRASS,  
CAUCASIAN BLUESTEM, AND A WARM-SEASON NATIVE GRASS MIXTURE  
FOR GRAZING STEERS (1959 - page 46)

Leaders: J. L. Launchbaugh and J. R. Brethour

Progress: Steer performance and grass yields for 1960 are shown in the following table:

| <u>Pasture</u>           | <u>Western<br/>Wheatgrass</u> | <u>Caucasian<br/>Bluestem</u> | <u>Switchgrass</u> | <u>Native<br/>Mixture</u> |
|--------------------------|-------------------------------|-------------------------------|--------------------|---------------------------|
| Carrying capacity, A/hd. | 2.2                           | 1.7                           | 2.2                | 2.5                       |
| Days on pasture, number  | 170                           | 88                            | 151                | 151                       |
| Gain per head, lb.       | 150                           | 60                            | 155                | 150                       |
| Gain per acre, lb.       | 67                            | 36                            | 70                 | 60                        |
| Forage production, lb/A  | 4,800                         | 4,125                         | 5,835              | 4,525                     |



Title: WARM SEASON GRASSES ON SANDY SOILS (1959 - page 47)

Leader: Marvin L. Lundquist, Sandyland Experiment Field, St. John, Kansas

Objectives: Observe establishment of these grasses - Sand lovegrass, Switchgrass, Big bluestem, Little bluestem, SCS Mixture, Caucasian bluestem, Turkestan bluestem, Sand bluestem, and Sideoats grama. Compare yields by clipping studies. Observe results of fertilizing.

Progress: Fertilizer studies were begun on selected species. The following comparisons are being made. All species were not treated the same because of plot size and stand of grass.

Sideoats grama - 0-0-0; 15 (+ 15)-0-0; 30-0-0; 30 (+ 30)-0-0; 30-45-0

Switchgrass - " " " " "

Turkestan bluestem, Sand lovegrass, Little bluestem, SCS Mixture of warm-season grasses

Sand bluestem - 15 (+ 15)-0-0; 30 (+ 30)-0-0; 0-0-0

(15 (+ 15)-0-0 means that 15 pounds of nitrogen (elemental) were applied April 27 and that an additional 15 pounds will be applied approximately June 20. No phosphorus or potash was applied.)

Observations to date on the plots receiving heavy applications show increased growth of undesirable weedy grasses such as little barley and annual bromes along with increased growth of the species tested. A greener color of plants is also evident on those fertilized.

Title: DIFFERENT METHODS OF MANAGING BLUESTEM PASTURES  
(1959 - pages 40 and 47)

Leaders: E. F. Smith, B. A. Koch and F. W. Boren, Department of Animal Husbandry, and K. L. Anderson, Department of Agronomy

Progress: Stocking rates, deferred grazing and pasture burning are being studied. Steer gains per head appear to be increased by mid and late spring burning, unaffected by early spring burning, and lowered by overstocking and deferred grazing. Burning and overstocking have reduced forage production; understocking and deferred grazing have improved forage production.

Title: SUPPLEMENTAL FEEDING OF STEER CALVES ON BLUESTEM PASTURE  
(1959 - page 48)

Leaders: E. F. Smith, B. A. Koch and F. W. Boren, Department of Animal Husbandry

Progress: A soybean meal and salt mixture gave about the same response when fed to steer calves on winter bluestem pasture as the same feeds fed in block form. Both feeds were self-fed.

Supplemental phosphorus studies are being continued under this project.

Title: WINTERING, GRAZING AND FATTENING HEIFERS (1959 - page 48)

Leaders: E. F. Smith, F. W. Boren, B. A. Koch and D. L. Good, Department of Animal Husbandry

Progress: Due to a severe winter snow storm it was necessary to discontinue the original treatments under this project. During the following summer the value of supplemental copper, cobalt, and copper and cobalt combined were investigated for animals being grazed on summer bluestem pasture. None of these treatments in which the trace minerals were supplied in the salt at about half the required amount gave a significant increase in gain over the controls.

#### MONTANA

Title: PALATABILITY OF SEVENTEEN GRASSES WHEN GRAZED AT THREE STAGES OF GROWTH (1959 - page 49)

Leader: Arthur L. Dubbs

Progress: One major change was made in this trial in 1960 in which one-half of each replication was fertilized with 50#/A of nitrogen (ammonium nitrate). The purpose of this was to determine the palatability of the various grasses at different stages of growth as affected by fertilization. Three sheep were used as the test animals. Results in 1960 showed that in the vegetative stage the fertilized portion was preferred as first choice and as the plants advanced in stages of growth, the unfertilized portion was preferred. This was because of the rank growth created by the fertilizer since sheep prefer short leafy plants. Fertilization did not extend the period of palatability nor did the varieties change in ranking as to when they were preferred by sheep.



Title: STANDARD CRESTED WHEATGRASS AND NATIVE SOD RENOVATION  
(1959 - page 50)

Leader: Arthur L. Dubbs

Progress: Field work has been completed, and data analyses are in progress.

Title: MORPHOLOGICAL DEVELOPMENT OF RANGE GRASSES AND THE EFFECT OF  
SIMULATED GRAZING ON GRASS MORPHOLOGY (1959 - page 50)

Leader: Gene F. Payne, Department of Animal Industry and Range Management

Progress: Clipping of bluebunch wheatgrass and needle-and-thread grass was continued. The results of the previous year were intensified, with more plants clipped to ground level in the spring and summer being reduced in productivity or dying. Partially clipped plants and fall-clipped plants maintained productivity at levels in direct relation to clipping. A dry summer reduced production on all plants.

Title: UTILIZATION OF GRAZING LAND BY RANGE SHEEP TO PREVENT DETERIORATION  
AND BUILD UP CARRYING CAPACITY (1959 - page 51)

Leader: Gene F. Payne, Department of Animal Industry and Range Management

Progress: Fences were maintained and gopher trapping continued. Vegetational studies planned for 1960 had to be deferred to 1961.

Title: RANGE FORAGE PRODUCTION CHANGES THROUGH WATER-SPREADING  
PRACTICES (1959 - page 51)

Leader: D. E. Ryerson, Department of Animal Industry and Range Management.  
Cooperating with Bureau of Land Management and Geological Survey,  
U. S. Department of Interior

Progress: Due to reductions in work funds on this study during 1960-61 only maintenance work was carried out. Permanent line transects were read on the upper, middle and lower portions of the spreader area and on the check area. Little to no change occurred in plant density on the check areas as compared to previous years. On the spreader area as compared to the previous year there was a decrease in plant cover for Nuttall saltbush, big sagebrush and Sandberg blue grass. Forage production on the semi-slick areas over the spreader system was about the same as the previous year. Reseeding success is still rated as poor.

Title: RANGE IMPROVEMENT THROUGH THE USE OF RENOVATION PRACTICES FOR UNDESIRABLE RANGE PLANT CONTROL (1959 - page 52)

Leaders: D. E. Ryerson, Department of Animal Industry and Range Management, and F. B. Gomm, Agricultural Research Service

Progress: A new phase was added involving the dual control of big sagebrush and rabbitbrush. Treatment forage yield and percent composition by weight of vegetation determinations were made. Average total foliage yield was 706 lb/A, of which grasses contributed only 43% and the remainder was composed of big sagebrush, rabbitbrush, phlox and other annual forbs. Chemicals were not applied, to permit the treatment plot analysis to be made.

Belt transects were established on tall larkspur areas and read in 1959 and 1960. In no case were all plants killed in any belt. Greatest reduction occurred in plots receiving 2,4,5-T at 2 lb/A. Several plants showed residual chemical effects and were reduced to one or two sprouts per plant.

Title: EVALUATION OF EXISTING, AND DEVELOPMENT OF NEW, RANGE MEASUREMENT TECHNIQUES (1959 - page 53)

Leader: George M. Van Dyne, Department of Animal Industry and Range Management

Progress: Attempts were made to improve the vegometer for forage production measurement. The reliability of the 5-foot transect equipment was verified. It was found that, on a theoretical basis, the point analysis system is sufficiently accurate to be valuable in range analysis work. This project is being inactivated.

Title: PALATABILITY, PRODUCTIVITY, AND CHEMICAL AND BOTANICAL COMPOSITION IN RANGE FORAGES AS INFLUENCED BY FERTILIZATION (1959 - page 53)

Leaders: George M. Van Dyne and D. E. Ryerson, Department of Animal Industry and Range Management, and Harry Kittams, Department of Agronomy and Soils

Progress: Analyses on the data of the past year have not been completed. The final fertilizer applications have been made, and field studies are continuing.



Title: NUTRIENT PRODUCTION OF RANGE PLANTS ON PLAINS, FOOTHILL, AND MOUNTAIN AREAS OF MONTANA (1959 - page 54)

Leaders: George M. Van Dyne, Department of Animal Industry and Range Management, and Harry Kittams, Department of Agronomy and Soils

Progress: Statistical analyses are still in progress. This project will be inactivated.

Title: EVALUATION OF THE QUANTITY AND QUALITY OF THE DIET OF RANGE SHEEP (1959 - page 55)

Leaders: George M. Van Dyne and J. L. Van Horn, Department of Animal Industry and Range Management

Progress: From two to five ewes were used in obtaining forage samples of grazed forage of freely grazing sheep. Forage collections were made morning and evening every other day throughout the three month winter grazing period. No data were collected on the grazing habits of the sheep since sheep were too closely herded to respond to weather changes. This project is being inactivated.

Title: FEED MANAGEMENT OF EWES ON A FOOTHILL RANGE (1959 - page 55)

Leaders: J. L. Van Horn, O. O. Thomas, J. Drummond, A. S. Hoversland and G. M. Van Dyne, Department of Animal Industry and Range Management, and F. S. Willson, Montana Wool Laboratory

Progress: The procedures outlined in the 1959 report were repeated. The data presently available is being summarized. The range phase of this project is being inactivated.

## NEBRASKA

Title: THE INFLUENCE OF DIFFERENT LEVELS OF STOCKING ON SUMMER LIVESTOCK GAINS AND THE CONSEQUENT CHANGES IN BOTANICAL COMPOSITION, RANGE CONDITION, AND QUALITY OF FORAGE ON WESTERN NEBRASKA RANGELAND (1959 - page 58)

Leader: D. F. Burzlaff, Department of Agronomy

Progress: Yearling steers were pastured at various intensities of grazing to continue the objectives of the project. Weights were taken at periodic intervals throughout the grazing season.

Forage samples were taken for chemical analysis at monthly intervals. Production and utilization of forage were determined by clipping procedures.

Light rates of stocking showed inferior animal performance (215 pounds of gain) to either heavy (217) or moderate stocking (233). These differences were not statistically significant. Pounds of beef per acre were highest on heavily stocked range.

An additional lot of steers were pastured at the moderate rate. These steers were provided a protein supplement after July 15. Protein supplement, when consumed at eight-tenths of a pound of crude protein per day for the last 91 days of the grazing season gave a 39-pound increase in total gain per animal.

The decrease in daily gains from month to month corresponded to similar decreases in protein content of forage.

There were no significant changes in composition of the vegetation and no change in range condition.

Title: FACTORS AFFECTING THE CLASSIFICATION OF RANGE SITES IN NEBRASKA SANDHILLS (1959 - page 58)

Leader: D. F. Burzlaff, Department of Agronomy

Progress: Work in 1960 involved a continuation of the study of soil moisture production of vegetation conditions on the sandy range site at Fort Robinson. The remainder of the time was spent in the preparation of manuscripts for publication.

In three years of sampling for soil moisture content, 87% of the samples taken at or below the two foot depth have been at or below wilting point for the soils. Forage yield data does not indicate that this severe soil moisture relationship has adversely affected the productivity of this range site.

A new technique for sampling vegetation is being developed. This involves the point quadrat technique using an optical instrument with cross hairs and focal mechanisms to select the point. Other features of the technique include randomization of point selection, improved accuracy and efficiency.



Title: CATTLE MANAGEMENT PRACTICES IN THE RANGE AREAS OF NEBRASKA  
(1959 - page 59)

Leader: D. C. Clanton, Department of Animal Husbandry

Progress: Cows and calves grazing meadow pastures gained 40 pounds and 6 pounds more, respectively, than cows and calves grazing hills pasture in a 148-day period in the Sandhills. These are the results of one comparison during the summer of 1960. The meadow pasture was 25% sub-irrigated, 60% dry valley and 15% sand. The hills pasture was choppy to gently rolling sandhills with some dry valley. It was in excellent to good condition. Grazing the meadow did not appear to have a detrimental effect on the meadow. Spot grazing was very pronounced. This experiment is being continued during 1961 using a different meadow. It is not anticipated the meadows should be pastured every year, but possibly every second or third year. The meadows should be hayed the years not pastured.

The use of the cobalt bullet on wintering calves and on summering yearlings has failed to produce additional gain over similar cattle not treated at three locations in Nebraska.

Title: EFFECT OF VARYING ENERGY AND PROTEIN LEVELS DURING THE WINTER ON PRODUCTIVITY OF BEEF COWS (1959 - page 59)

Leader: D. C. Clanton, Department of Animal Husbandry

Progress: Thirty-two bred yearling heifers were divided into four groups of eight head each. They were individually fed one of four rations for 140 days during the winter (1959-60). Each heifer was fed on the basis of her size. The rations were: (1) low protein-low energy, (2) low protein-high energy, (3) high protein-low energy, and (4) high protein-high energy. The low level protein was one-third and the high level was approximately two-thirds the digestible protein recommended by the N.R.C. The low energy level was one-half and the high level was approximately two-thirds the digestible energy recommended by the N.R.C. The heifers were fed a common ration during and following calving. More difference was observed in the growth and condition of the heifers due to the two energy levels than due to the two protein levels. The high energy fed heifers performed well and out-performed the low energy fed heifers in most respects. Their average interval from calving to first heat cycle was 52 days, whereas the low energy fed heifers averaged 146 days. The low protein fed heifers grew and maintained themselves better than the high protein fed heifers following the winter treatments. The high protein fed heifers out-performed the low protein fed heifers in terms of milk and calf production. The low protein fed heifers used their nutrients during the summer to build their own body rather than to produce. Regarding the development of the heifers, it was harmful to feed the high protein ration without doing the same with energy. There evidently is a desirable balance between the two.

Title: THE EFFECT OF HORMONE IMPLANTS IN BEEF PRODUCTION ON WINTER AND SUMMER PASTURE (1959 - page 61)

Leaders: J. K. Matsushima, L. Harris and D. F. Burzlaff

Progress: Eighty head of weanling steer calves were purchased in the fall of 1960. Twenty head were implanted with thyroxine and testosterone implants on November 5, 1960. No additional implants will be made on any of the cattle until the fall of 1961 when they go into the feedlot for fattening. On May 12, 1961, the eighty calves were assigned to various treatments for summer grazing experiment.

Title: THE INTRODUCTION, MULTIPLICATION, PRESERVATION, AND DETERMINATION OF THE POTENTIAL VALUE OF NEW ACCESSIONS AND STRAINS OF NATIVE AND EXOTIC GRASSES (1959 - page 62)

Leader: L. C. Newell, Agricultural Research Service

Progress: Forty accessions of little bluestem and 1000-plant selection-nurseries of three types each of tall wheatgrass and intermediate wheatgrass were added to seedling nurseries in 1960. Clonal selections were made in older plantings of cool-season grasses, as well as screening four introductions of pubescent wheatgrass, 33 collections of western wheatgrass, and an advanced-generation hybrid population of crested wheatgrass derived from PI 172691 and PI 180794. Superior clones selected in this population for good forage, including spreading habit, were moved to isolation groupings of six spike types, emphasizing seed quality characteristics. Space-planted clonal nurseries of six cool-season and nine warm-season grasses were maintained in isolated plantings by type or maturity class. In addition to the wheatgrasses in the cool-season group, two types of brome grass were maintained for observation and progeny testing. In the warm-season group clonal nurseries were maintained or initially established for a total of eight types of switchgrass, five groups of little bluestem, three groups of Indiangrass, two groups of bluegrama, 20 types of big bluestem and sand bluestem, and plantings of side-oats grama, sand lovegrass and buffalograss.

Future Plans: Clonal selections exhibiting desirable agronomic characters will be added to holding nurseries. New groups will be established for the clonal selections of pubescent, intermediate and tall wheatgrass.

Title: CHEMICAL, MORPHOLOGICAL AND NUTRITIONAL CHANGES OCCURRING IN GREAT PLAINS GRASSES AND THEIR RELATIONSHIP TO MANAGEMENT PRACTICES (1959 - page 63)

Leaders: G. VanRiper and D. F. Burzlaff, Department of Agronomy

Progress: Successful stands of three grasses were established at Fort Robinson during 1960 by the use of larger plant parts and irrigation. The same three grasses (little bluestem, sand bluestem and sandreed) were sampled at six different stages of growth from native stands at Fort Robinson. The



herbage, stem bases, rhizomes and roots are being analyzed for chemical constituents. Techniques were developed at Lincoln for studying switchgrass rhizomes and crown growth by in vitro methods. It was found that 20 mm sections of rhizome material could be grown in 0.6% agar media supplied with nitrogen in the form of  $\text{KNO}_3$  or  $\text{NH}_4\text{NO}_3$  in 125 ml erlenmeyer flasks. Complete nutrient media promoted mold growth which inhibited bud growth of rhizomes. Shorter sections than 20 mm had insufficient food reserves to grow properly and sections which were submerged in agar or placed in a horizontal position appeared to be limited on  $\text{O}_2$  supply for optimum growth. Sections placed in a vertical position and immersed about 10 mm grew the best regardless of whether the rhizome buds were in geotropic or a negative geotropic position. Rhizome buds appeared to be dormant during July and August. However, during October and subsequent winter months the buds grew actively in agar cultures.

**Title:** A TESTING PROGRAM TO DETERMINE THE REGIONAL ADAPTATION OF CROP VARIETIES AND CULTURAL PRACTICES IN NEBRASKA

**Leaders:** Dennis D. Warnes, Outstate Testing, Agronomy Department. Cooperating with L. C. Newell, Agricultural Research Service

**Objective:** To determine the adaptation and potential utilization of varieties and strains of grasses in different environments of Nebraska.

**Procedures:** Beginning with 1961, plans are for Outstate Testing to begin a program of testing new experimental varieties and strains of the warm-season grasses. Included in 1961 tests are twenty varieties and strains of bluestem, switchgrass, indiangrass and sideoats grama selected from the Nebraska grass breeding program with presently recommended varieties used as checks. Plantings were made at four locations in the spring of 1961 in Antelope, Platte, Gosper and Dundy Counties. Included in each test is a fertilizer variable of a starter application versus a check. Plantings were made into sorghum stubble with minimum disturbance of surface soil. During the seedling year some weed-control measures will be practiced.

## NEVADA

Title: CHANGES IN VEGETATION OF SPRING-FALL, AND WINTER RANGE TYPES IN NEVADA DURING 23 YEARS PROTECTION FROM GRAZING

Leaders: Ralph C. Holmgren and J. H. Robertson

Objectives: (a) To learn the degree of change in botanical composition on the range types sampled, (b) to learn the rate of trend in condition, (c) to interpret the changes found.

Progress: At 16 locations in western and northern Nevada, 4-acre areas were fenced in 1937 to exclude livestock. In a corner of each livestock enclosure, a 6,400-square-foot area was fenced with fine-mesh wire to exclude rabbits and all rodents except pocket gophers. The smaller enclosures are referred to as "rabbit" enclosures, because jackrabbits are the most important species excluded from them. Ground squirrels, kangaroo rats, and other small mammals, however, are also excluded.

At regular intervals over the past 23 years, observations have been made on the vegetation in the enclosures to provide a record of changes in composition of the plant cover.

The greatest differences in plant species composition between associated enclosures are on study areas in the big sagebrush type, the habitat of jackrabbits.

At all locations there has been a substantial increase in perennial grass since construction of the fences.

Perennial forbs have become important constituents of the cover only on the big sagebrush sites. As with perennial grass, small mammals influenced the rate of increase of forb species, most of which are of little value as livestock forage.

Title: ECOLOGY AND MANAGEMENT OF INDIAN RICEGRASS (ORYZOPSIS HYMENOIDES)

Leaders: F. E. Kinsinger and J. H. Robertson

Objectives: To learn enough of the ecology of Indian ricegrass to make reliable recommendations on practices for: (a) improvement of existing stands, and (b) establishment of new stands.

Progress: Herbage of Indian ricegrass clipped from replicated 300 ft.<sup>2</sup> plots near Tonopah during 1959 and 1960 indicates that best yields result from harvesting once in late fall where the plots have been sprayed in May with 2,4-D. Spring clipping of the shrubs followed by close fall clipping of the grass ranked second.



Close clipping the first of each month during the growing season depressed yield the most. Five other treatments produced yields of intermediate rank. In a similarly designed experiment near Pioche, the top yields have been from close clipping of the shrubs and one close clipping of the ricegrass in late fall.

Clipping at one inch height in the leaf stage about May 1, or at bloom stage around June 1 minimized production.

Yields at Pioche were lower than in any recent year except 1959. At Tonopah the combined yield was only half as much as last year and eight per cent of that of the first year of treatment, 1956.

An analysis of the relation of seedling leaf-length to natural depth of planting on the range brought out a significant positive correlation. Seed depth and survival after two years were also positively correlated, but the degree of association was less intense.

Title: ECOLOGY AND MANAGEMENT OF WHITESAGE (EUROTIA LANATA)

Leaders: F. E. Kinsinger and J. H. Robertson

Objectives: To learn enough of the ecology of whitesage to make reliable recommendations on practices for: (a) improvement of existing stands, and (b) establishment of new stands.

Progress: Effort during the last year has been concentrated on continued clipping studies.

The second season of simulated heavy utilization was completed. Five treatments were applied at each of three stations. The yield at Clover Valley of all winter clipped plots was about twice as much in 1960 as in 1959. The plots at Mill City produced from one to five times as much dry matter as in 1959. Winter clippings from plots at both Clover Valley and Mill City were slightly lower in protein if burned in 1959 than if not burned. At Ely (Steptoe Valley) winter yields were higher on three treatments than in 1959: 80% of current growth, clipped at a uniform height of two inches, and clip all current growth yearly since burning in 1959. Only a few stunted plants of halogeton were present even in the closest clipped winter plots in Clover Valley.

Close winter utilization of whitesage for eight years has failed to break up the stand or open it to serious invasion. Heavy use with trampling outside the exclosure has resulted in a dense stand of halogeton. Without trampling, however, halogeton has occupied bare spots within the Clover Valley exclosure.

Title: REPLACEMENT OF SALTDDESERT SHRUBS BY MORE DESIRABLE SPECIES

Leader: J. H. Robertson

Objective: To find methods by which adapted, palatable grasses and shrubs can be established on a shadscale site.

Progress: After inspection of many shadscale ranges from U.S. 50 northward, four were selected for additional study of vegetation and soil.

Soil fertility trials conducted in the greenhouse indicated that nitrogen is a limiting element at all four sites, and that soil fertility is higher at Paradise Valley than at the other three sites.

Paradise Valley, the site with the densest, tallest, purest stand of shadscale, and the most litter and soil fertility, was selected for field seeding trials in October 1959 and 1960. Results, as yet, are inconclusive. Pitting had little effect upon seedling emergence while sand mulch gave a pronounced increase. Survival counts on 1959 plantings may prove more conclusive in May 1961.

Two species of Atriplex were transplanted from the greenhouse to the Paradise Hill plots May 14, 1960. Both species survived the summer drought and were growing vigorously on September 25, 1960.

Future Plans: Methods and varieties will be repeated for the third year. Several additional exotic varieties will be included and ratings of established stands will be made.

Title: PERSISTENCE OF SEEDED GRASSES IN ASSOCIATION WITH BIG SAGEBRUSH

Leaders: J. H. Robertson, R. E. Eckert and A. T. Bleak

Objective: To learn the relative adaptabilities and competitive strengths of various grasses under moderate grazing.

Progress: Twenty grasses and palatable weeds were planted on a well-prepared seedbed in sagebrush clearings in March 1943. Six 7 x 10-foot plots of each kind were sown, cultivated, and protected from stock until 1946. Thereafter they were open to grazing after maturity and during the winter.

As a rule, plots with unsuccessful species were rapidly colonized by cheatgrass and big sagebrush while those with ratings of good to excellent suffered little or no invasion.

Most of the grasses produced higher yields in their second year than in any of the other seven years of harvest. In the eleventh year, however, yields of six grasses were again remarkably good. These were grasses that had been most successful in excluding cheatgrass and sagebrush. Tall wheatgrass produced 16 per cent more, crested wheatgrass 19 per cent, Russian wildrye 47



per cent, intermediate wheatgrass 67 per cent, pubescent wheatgrass 72 per cent, and beardless bluebunch wheatgrass 208 per cent more than in any year before or since. Beardless bluebunch wheatgrass had steadily enlarged its bunches and its yield while yields of the other five grasses had fallen to relatively low levels in 1946 and 1948.

Future Plans: Soils will be described for the site. The existing data on grass and brush invasion and growth will be analysed for relationships to the three treatments applied at the time of establishment, but not detailed above.

## NEW MEXICO

Title: ECONOMIC APPRAISAL OF DROUGHT AND DROUGHT-RECOVERY PRACTICES ON RANCHES IN NEW MEXICO (1959 - page 65)

Leaders: C. C. Boykin, Agricultural Research Service, and J. R. Gray, Department of Agricultural Economics

Progress: Costs and returns have been determined for 16 case ranches for pre-drought, drought and post-drought periods extending from 1948 through 1959. Total livestock productivity was maintained and in some instances increased during the drought as compared with the pre-drought period. Increased costs, especially for feed, fuel and hauling, interest, and leases, when combined with the effects of lower prices received for livestock, resulted in a lower net ranch income than in pre-drought or post-drought periods. Attempts by ranchers to offset these price and cost effects were made in the form of reducing expenditures for hired labor, repairs, and deferring investments in large capital improvements. Non-ranch income increased during the drought as a result of other employment or investments, and most ranchers attempted to reduce family living expenses. As the drought ended, ranges improved; however, the effects of drought and grazing on range productivity have not been determined. Many ranchers indicated that they were stocked on the basis of the "drier" years and expected the range to recover as moisture conditions improved.

Future Plans: Examination of alternative drought and drought-recovery practices and the effect on net ranch income will continue.

Title: ARTIFICIAL REVEGETATION OF DESERT GRASSLAND RANGE IN NEW MEXICO (1959 - page 66)

Leaders: J. J. Norris and K. A. Valentine, Department of Animal Husbandry

Progress: Under the Planting Methods section of the project, planting trials were made to determine the influence of seed quantity, planting time, furrow versus flat bed planting, fertilization, mulching and removal of competing vegetation on stand. All trials were made with black grama grass. Rainfall

at the three planting sites was 2.00, 2.20 and 3.40 inches for the July-September period. Practically no emergence was obtained under the 2.00 and 2.20 inch rainfall values, and but few seedlings appeared under the 3.40 inch rainfall. Variations in seedling numbers was so great within treatments as to afford no reliable indications of the values of the treatments. Unprecedented frost heave destroyed all seedlings which had become established on the planting sites.

Future Plans: The planting trials will be repeated as before.

Title: INFLUENCE OF GRAZING USE ON RECOVERY OF DROUGHT DAMAGED DESERT GRASSLAND RANGE (1959 - page 66)

Leaders: J. J. Norris and K. A. Valentine, Department of Animal Husbandry

Progress: Grazing treatments were suspended for the 1960-61 year owing to severe drought and lack of forage production at the three locations where the grazing plots are established.

Future Plans: Grazing treatments will be resumed when forage production permits.

Title: RELATION OF INSECTS TO SEED PRODUCTION AND RE-ESTABLISHMENT OF RANGE GRASSES (1959 - page 68)

Leader: S. R. Race, Department of Botany and Entomology

Progress: Western harvester ants were controlled for several months by broadcast and nest applications of seed baits treated with heptachlor, Kepone, aldrin, dieldrin and S. D. 4402. Insecticidal dusts or granules failed to give adequate control. Ecological studies revealed that 70% of the nest entrances were located in the southeast quadrant of the mounds. Early morning temperatures on the eastern slopes of mounds increased faster than on the other sides. The location of entrances on the eastern slope probably permits earlier morning ant activity. Nine ant species were recorded in 1960. Of these, two were harvester ants. Food preference studies show acceptance of many types of seeds. No single bait was more preferred than any other. Bi-monthly black grama grass samples showed Chirothrips adults present every month. Large numbers appear with the on-set of new grass growth, especially seed heads, and continue through November. Numbers decline rapidly from December to April and only occasional specimens are found from May to July. Numbers increase some in August and reach a peak from September to November. No males were found between December and September, except for two in July. Extensive efforts to locate larvae were fruitless.

Insufficient rain resulted in no black grama seed, and no new data were taken on the relation of thrips to seed set. Thirty species of miscellaneous insects from black grama grass were identified. None were reasonably associated with the poor seed set problem.



Title: CONTROL OF MESQUITE ON DESERT PLAINS GRASSLAND RANGE  
(1959 - page 67)

Leaders: K. A. Valentine and J. J. Norris, Department of Animal Husbandry

Progress: Precipitation during the winter and spring of 1959-60 before spraying dates in May and June, adjusted for month of occurrence, was only 0.92 inch, compared with the approximately 1.2 inch adjusted precipitation necessary for support of good kills from 2,4,5-T spraying. Consequently, work was limited to small scale formulation and additive tests, and results obtained were poor. Monuron dosages in the order of one gram per lineal foot of crown spread up to 10 feet appear to give effective control, but the indicated size-dosage relationship is not altogether consistent. Monuron produced greater kills than fenuron at all dosages and in all years. Dry application of monuron produced an average kill of 25 per cent while application in water produced an average kill of 38 per cent, with no difference between one and four quarts of water.

Future Plans: Work will be continued as planned, including field scale application of 2,4,5-T and monuron in order to determine cost and effectiveness on a field scale basis.

Title: FORAGE PRODUCTION AND APPRAISAL (1959 - page 67)

Leaders: K. A. Valentine and J. J. Norris, Department of Animal Husbandry

Progress: Results remain about as previously reported. Owing to variation in stand of forage yielding grasses from time to time and place to place, correlation of forage production and growing season rainfall is barely significant. Forage production shows highly significant correlation with the product of growing season rainfall and stand of forage yielding grasses. Personal estimate methods of forage appraisal, requiring much less time than the rainfall times stand method, approach and in some instances exceed the precision of the more objective rainfall times stand method; however, considerable variation between methods and persons has been experienced.

Future Plans: Work will be continued in observation of forage production and appraisals.

Title: RODENT POPULATIONS OF THE DESERT GRASSLAND RANGE AND FACTORS AFFECTING THEIR NUMBERS (1959 - page 68)

Leader: J. E. Wood, Department of Animal Husbandry

Progress: The New Mexico Agricultural Experiment Station ranch was cover-mapped into nine wildlife cover types, and the 14 species of rodents present in the area were censused to determine the density and distribution among cover types. The greatest number of species of rodents was found in the annual weed and creosotebush types. The least number was recorded in the poor condition black grama and good condition tobosa types. The greatest density

per section of cover type was recorded in the mesquite dune type (6528) and the least density in the good condition tobosa type (1536). In terms of biomass, the greatest (844 lb. per section) was recorded for the creosotebush invading grassland type, with the mesquite dune type being a close second with 840 pounds per section.

Poisoning operations by the standard den to den method yielded an 80% control of the rodent population, whereas a 98% control was obtained when the poison grain was distributed in a grid pattern.

Future Plans: Population evaluations on controlled and non-controlled populations in the various cover types will be continued. Three 1-acre enclosures will be stocked with known numbers of rodents to observe their productivity, behavior and effects on the vegetation.

#### NORTH DAKOTA

Title: BOTANICAL COMPOSITION AND FORAGE PRODUCTION OF NATIVE GRASS GRAZING LANDS IN WESTERN NORTH DAKOTA (1959 - page 69)

Leaders: Warren C. Whitman, Department of Botany, M. L. Buchanan and D. W. Bolin, Department of Animal Husbandry

Progress: During the 1960 season new cages were placed on five range sites in each of two different condition classes. Ten cages were placed on the study area in each of the range condition classes on each site. Yield clippings were made from the cages at the end of the season. Leaf and stalk heights were measured prior to clipping.

Very definite differences in total grass production and in vigor of the principal forage producing species as shown by differences in height growth were observed between vegetation in excellent condition and in low-good condition on the same site. Production of grass from the lower condition vegetation averaged about 52 per cent of the production from high condition vegetation on five different sites. Leaf heights of the major grass species on low condition range averaged only one-half to two-thirds of the leaf heights of the same species on high condition range.

Differences in composition of cover, as determined by point sampling, were not as marked nor as consistent as were the differences in forage production and leaf heights between the vegetation in different condition classes on the same sites.

Future Plans: Present studies will be continued. It is planned to add three additional sites with vegetation in at least two different condition classes.



Title: VALUE OF CRESTED WHEATGRASS AND CRESTED WHEATGRASS-ALFALFA  
PASTURES FOR SPRING GRAZING (1959 - page 70)

Leaders: Warren C. Whitman, Department of Botany; R. J. Douglas, Larkin  
Langford, Dickinson Station; and M. L. Buchanan, Department of  
Animal Husbandry

Progress: The pastures in the spring grazing trial were grazed for the sixth  
season in 1960. Yearling steers were on the pastures from May 2 to July 14, a  
period of 73 days. Forage production and forage consumption on the pastures  
were determined by means of clippings inside and outside movable steel cages.  
One of the straight crested wheatgrass pastures was fertilized with 50 lb.  
nitrogen per acre.

This year the crested-alfalfa pastures produced about 27 per cent more forage  
than straight crested wheatgrass, while the fertilized crested produced 51 per  
cent more forage than straight crested and 19 per cent more than the crested-  
alfalfa pastures. Gains per acre were 101 lb. on straight crested, 137 lb.  
on crested-alfalfa, and 165 lb. on fertilized crested. On the basis of this  
preliminary trial with nitrogen, it would appear that substantial and economi-  
cal increases in forage production and gains may be obtained through fertili-  
zation of spring pastures such as these.

Future Plans: These pastures will be grazed as before. It is planned to  
fertilize two of the pastures with nitrogen and to leave two unfertilized. A  
new summer grazing trial is being planned, and the spring pastures will be  
grazed in conjunction with the summer pastures.

Title: NATIVE RANGE PLANTS - THEIR GROWTH AND DEVELOPMENT IN RELATION TO  
THE ESTABLISHMENT OF STANDARDS FOR THEIR PROPER UTILIZATION  
(1959 - page 71)

Leaders: Warren C. Whitman and E. A. Helgeson, Department of Botany

Progress: Work done on this project in the 1960 season included the continu-  
ation of the growth and development measurements of the important forage gras-  
ses and the clipping of the square-foot growth-increment plots. In addition,  
the study of grassland microclimate was continued in essentially the same  
manner as in the 1959 season.

The increment clippings and growth measurements of the major native grass  
species show that the growth of most grasses is complete by mid-July. Many  
of them make very little growth after the end of June. Last season soil mois-  
ture was deficient for grass growth after mid-June.

Measurements of temperature, relative humidity, evaporation, and wind move-  
ment at heights of five inches and five feet over the grassland indicate that  
definite microclimatic effects exist with evaporation and wind movement being  
much greater at five feet than at five inches. More refined instrumentation  
is needed to characterize the nature and importance of these effects.

Future Plans: Basic scientific data on the growth rates of the major forage species in the grassland and the response of these species to macroclimatic and microclimatic influences under various clipping treatments will be obtained.

## OKLAHOMA

**Title:** AERIAL AND GROUND APPLICATIONS OF HERBICIDES FOR OAK AND OTHER HARDWOOD CONTROL FOR NATIVE GRASS IMPROVEMENT OR PINE RELEASE

**Leader:** Harry M. Elwell, Crops Research Division, in cooperation with Agronomy Department, Oklahoma State University

Objective: To determine degree of hardwood control by various methods of applications and effects on the improvement of native grass and shortleaf pine.

Progress: 1. Aerial Applications of Herbicides. A. Drift Studies. Control of drift of phenoxy herbicides in spray solutions, aerially or ground applied, is an important problem in the continued use of these chemicals for brush and weed suppression. The use of invert emulsion or thickened sprays appears to be an important aid in controlling spray drift. Better equipment for mixing and applying the invert emulsion or thickened spray is needed for effective use of such sprays.

B. Woody Plant Control. The low-volatile ester of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) and 2-(2,4,5-trichlorophenoxy) propionic acid silvex are the best herbicides for general brush control for native grass improvement. These materials have a wide range of effectiveness on woody species, and their action in foliar sprays apparently was not materially influenced by soil variation.

Defoliation and apparent kill of oak and hickory were about equal from comparable aerial applications of 2,4,5-T ester in either butoxy ethanol, propylene glycol butyl ether or in isocetyl formulations.

Pellets 25% active of 3-phenyl-1, 1-dimethylurea (fenuron) have effectively controlled post and blackjack oaks at 20 to 24 pounds (five to six pounds of active ingredient) on deep sandy soil. This herbicide was less effective on clay loam than on deep sandy soils.

None of the presently available phenoxy herbicides or economical rates of fenuron and 2,3,6-trichlorobenzoic acid (2,3,6-TBA) in aerial applications have satisfactorily controlled elms, hawthorn, small-flowered dogwood, ash, and huckleberry.



Desirable native grass recovery has been good to excellent on all areas aeri-ally treated with 2,4,5-T and silvex throughout central and western Oklahoma. Sites treated in eastern Oklahoma should be carefully selected to make sure they will grow good native grasses. Broom sedge and other weedy grasses often take over on areas aeri-ally treated with herbicides in the eastern third of Oklahoma.

2. Application of Experimental Herbicides with Hand and Powered Equipment. Hard-to-kill Species. All species of elm common to Oklahoma have been hard to kill with 2,4,5-T by foliar, basal-bark, or injector treatments. The 2,4,5-T in low-volatile ester formulation at three pounds of acid per 100 gallons of water has caused a high percent of defoliation, but plants gener-ally produce trunk or root sprouts rather profusely.

Persimmon has been eliminated with 0.5 pound of 2,4,5-T ester per acre in each of three applications of foliar water sprays. By spacing applications one or two years apart, the regrowth and sprouts have been killed. Persimmon has not been satisfactorily killed with 2,4,5-T ester applied as basal-bark treatments. Fenuron pellets, 25% concentration at 15 pounds of active chemical per acre, had little or no effect on persimmon.

Hawthorn was effectively controlled with 20 pounds of low-volatile ester of 2,4,5-T per 100 gallons of diesel oil applied in basal-bark and injector treatments. Hawthorn brush and trees were not satisfactorily controlled with two, four, and six pounds of acid per 100 gallons of diluent with silvex, 2,3,6-TBA, 2-chloro-4-fluorophenoxy acetic, and three 2,4,5-T formulations. Fenuron and 3-(P-chlorophenyl) 1, 1-dimethylurea (monuron) each at 6, 8, 12, and 15 pounds of active chemical per acre, had very little effect on hawthorn.

Salt cedar was effectively controlled with fenuron pellets 25% active at eight pounds of active chemical per acre on fairly deep sandy soil.

Greenbrier was satisfactorily controlled in a bermudagrass pasture for two years by spraying the foliage and stems with low-volatile ester of 2,4,5-T, containing an added wetting compound, two pounds of acid in 20 gallons of water per acre.

Buckbrush has been effectively controlled by butyl ester or low-volatile ester formulations of 2,4-dichlorophenoxyacetic acid (2,4-D). The most consistent kills have been with two pounds of 2,4-D acid per acre in spraying the foliage. This brush has to be treated during May 10 to June 15 to obtain effective control. Re-treatments are necessary to eliminate buckbrush with 2,4-D.

3. Hardwood Control with Aerially Applied 2,4,5-T for Pine Release and Pasture Development. Pines of all sizes have been more severely affected by September aerial applications with 2,4,5-T than by May applications. Ester and amine formulations of 2,4,5-T were about equal in degree of injury to pines. However, all defoliated pines with terminal twig injury from 2,4,5-T applications recovered the year following treatment and made apparently normal growth.

September applications did not satisfactorily control oaks and hickory. However, fair to good control of oaks and hickory was obtained from three annual 2,4,5-T applications in May. The ester formulation was most effective. Each annual treatment was with 1.5 pounds per acre in five gallons of water.

Grass recovery was poor even where good oak and hickory suppression occurred. A dense stand of seedling pines nearly excluded the native grasses.

Title: WEED CONTROL WITH VARIOUS HERBICIDES APPLIED IN SOIL AND FOLIAGE TREATMENTS FOR MAINTENANCE OF NATIVE GRASSES (1959 - page 75)

Leader: Harry M. Elwell, Agricultural Research Service, in cooperation with Agronomy Department, Oklahoma State University

Progress: 1. Soil Treatments (March and April). The herbicides diuron, fenac, 2,3,6-TBA, 2,3,5,6-TBA, butyl and combination esters of 2,4-D, 2,4-D granules, and simazin produced fair to good weed control the first year after application. These and other herbicides had no residual effects on weeds the second year following application. None of the herbicides tested during the March and April period noticeably suppressed desirable or weedy grasses.

2. Foliage Applications (May-June). The most consistently effective control of weeds was from ester formulations of 2,4-D; 0.75 to 1 pound of acid gave about equal control in 1958. The high- and low-volatile esters of 2,4-D were equally effective on small plots treated in 1959, but the low-volatile ester of 2,4-D at 0.75 pound of acid per acre gave 17% greater weed suppression than the high-volatile ester in 1960. The other herbicides used in foliar applications gave effective weed control. None of the herbicides tried in foliar tests had any effect on weeds beyond the first year after application.

3. Aerial Tests. Control of western ragweed (Ambrosia psilostachya D.C.), annual broom weed (Cutierrezia dracunculoides D.C. Blake) and miscellaneous weeds was fair from 0.5 pound of 2,4-D acid per acre applied aerially. However, 0.75 and 1 pound of 2,4-D acid per acre gave a greater total weed kill. None of the native legumes commonly found in native grasslands were materially affected with even 1-pound rate. The desirable grasses made good growth on areas having greatest weed suppression.

A spray solution containing 0.75 pound of 2,4-D in three gallons per acre gave a greater total kill of weeds than the same amount of 2,4-D in 1.5 gallons.

Water, oil-in-water, and diesel oil were about equal as carriers for 2,4-D. Water as a diluent for 2,4-D spray gave good foliage coverage and weed kill, especially when plants were growing actively. Under droughty conditions, an oil-in-water diluent (1:4 ratio) for 2,4-D spray has generally given best results.

By eliminating about 1,500 pounds of western ragweed growth, an additional 1,000 pounds of native grass were produced during 1958.



Title: TESTING, ESTABLISHMENT AND MANAGEMENT OF PASTURE PLANTS FOR OKLAHOMA

Leader: Wayne W. Huffine, Agronomy Department, Oklahoma State University

Objective: To determine area of adaptation, yield and stand persistence of native and exotic range grasses.

Progress: Forage production of native and exotic grasses in 1960, Perkins, Oklahoma.

| Variety                        | Total Yield           |                |
|--------------------------------|-----------------------|----------------|
|                                | Lb. Oven-Dry Forage/A | Multiple Range |
| Caucasian bluestem             | 5171                  |                |
| Caddo switchgrass              | 5134                  |                |
| Woodward sand bluestem         | 4955                  |                |
| K. R. bluestem                 | 2134                  |                |
| Elkan bluestem                 | 1091                  |                |
| Marash bluestem                | 929                   |                |
| Formosa bluestem               | 472                   |                |
| <u>Bothriochloa intermedia</u> | 339                   |                |

C. V. = 28.5%

L. S. D. 5% = 1262 lb.

## OREGON

Title: PROFITABILITY OF IMPROVEMENT PRACTICES FOR OREGON RANGELAND (W-16)

Leaders: William G. Brown, Department of Agricultural Economics, D. W. Hedrick, Department of Range Management, and D. N. Hyder, Squaw Butte Experiment Station, ARS

Objectives: 1. To estimate the effect of range improvement practices (with emphasis on chemical control of sagebrush, reseeding, and related management practices) on range forage production and utilization and the costs associated with these practices.

2. To evaluate the impact of the aforesaid range improvement practices on expected costs and returns over time for ranches of varying size and resource combination.

3. To interpret findings related to objectives 1 and 2, so as to estimate the probable impact of the range improvement practices on the production and the economy of the Oregon rangeland area.

Progress: On the basis of available data, estimation of rates of return from investments in range improvement practices were made by the use of linear programming. While the basic physical and economic data underlying the analysis were not adequate for the formulation of practical recommendations, the analysis did have value in specifying the type of information needed in applying linear programming to this problem. It also illustrated the kind of information which could be obtained from this type of analysis and the potential value of such findings.

Title: PLANT SUCCESSION ON DOUGLAS-FIR CLEAR CUTS AND THEIR ASSOCIATED MICROENVIRONMENTS

Leaders: W. W. Chilcote, Department of Botany and Plant Pathology, W. K. Ferrell, Department of Forest Management, C. E. Poulton, Department of Range Management, and C. T. Youngberg, Department of Soils

Objectives: 1. To describe the patterns of vegetation change (plant succession) during the first ten years following cutting in the Douglas-fir forest type of western Oregon.

2. To determine the microenvironment in and near the ground associated with this vegetation change.

3. To establish relationships between successional stages and their associated microenvironments.

4. To more clearly define the mechanisms operating at the seed bed level that are involved in vegetation change.



Progress: This project is primarily aimed at basic forest ecology, but it has a direct bearing on the management of game ranges. A point-frame method is being used to follow successional changes in the understory vegetation. Temperature and moisture conditions in and near the ground are being studied.

Title: SELECTIVE AND NON-SELECTIVE WEED CONTROL ON AGRONOMIC CROPS AND NON-CROP LAND AND FACTORS AFFECTING CONTROL PRACTICES  
(1959 - page 93)

Leaders: W. R. Furtick, W. O. Lee, A. P. Appleby, F. E. Phipps, R. W. Baldwin, and W. L. Gould. Cooperating with the Oregon Branch Experiment Stations

Progress: Many experimental herbicides from the chemical industry, both domestic and foreign, were evaluated. Chemical winter fallow with amatrole combined with 2,4-D provided some leads for use in experimental control of annuals on rangeland. A large number of compounds were screened in the greenhouse against cheatgrass (Bromus tectorum). Several materials appear promising and will be field-tested during 1962. Triazine herbicides were evaluated for selective weed control on grass seed crops, such as fine fescue and perennial ryegrass. These herbicides were also evaluated for fall control of annual weeds in birdsfoot trefoil. The treatments appeared promising. Diuron herbicide was tested on numerous common varieties of grasses. Great varietal differences in tolerance were found. Among the bent grasses and perennial ryegrasses information was obtained on the most effective timing and rate of application of MCPA and IPC for control of vetch, grasses and other weeds in crimson clover. A program for the control of quackgrass was established. The site of action and soil behavior of EPTC was investigated. This work is leading to increased efficiency and dependability in the use of volatile materials of this type.

Title: DEVELOPING IMPROVEMENT AND MANAGEMENT PRACTICES FOR SEMI-ARID RANGES AND FOOTHILL PASTURES (1959 - page 94)

Leaders: D. W. Hedrick, C. E. Conrad, and C. E. Poulton, Range Management Program. Cooperating with the Squaw Butte Experiment Station, ARS; U. S. Forest Service; Bureau of Land Management; Union Branch Experiment Station; Soils; Farm Crops; Agricultural Economics; and Botany

Progress: Western Oregon. The fertilizer-clipping study running for the period 1957-60 was completed. Stand establishment difficulties have precluded activation of a study on the compatibility of subclover and various companion plants under three clipping systems. A similar experiment to test various strains of alta fescue and other grasses with and without subclover under grazing use was established. Eighteen 5-acre pastures were seeded to subclover and perennial ryegrass, and to subclover and alta fescue in preparation for a study comparing these combinations under common use grazing by sheep and cattle. The proportion of sheep to cattle will be a variable in the experiment.

Eastern Oregon. Observations are continuing on the ability of grasses alone and grass-alfalfa combinations to resist reinvasion of sagebrush and rabbitbrush in the Fort Rock area. Studies of succession, following sagebrush removal by rotobating and spraying, were continued. This experiment includes fair and poor condition range as a variable. Vegetation changes are being followed by four methods, including yield. On fair condition range, almost all the increase is in the perennial grasses; whereas on the poor condition range, only about one-third of the increase is perennial grasses. Brush species (big sagebrush and rabbitbrush) have partially reinvaded on all treatments of the poor condition range and on the rotobeat treatment of the fair condition range.

Title: PLACE OF FORESTRY, GRAZING, OR JOINT USE ON FOOTHILL LANDS IN OREGON (1959 - page 95)

Leaders: D. W. Hedrick, C. E. Conrad, C. E. Poulton, Department of Range Management; R. F. Keniston, Department of Forestry; and J. A. B. McArthur, Union Branch Experiment Station

Progress: Investigation of the interrelationship between sheep grazing and Douglas-fir growth in the Oregon oak-type was concluded. Proper sheep grazing increases Douglas-fir height growth, in part, by making more soil moisture available to the trees. Sheep weight gains were made only on the pasture plot and the thinned, underplanted plot. Most Douglas-fir browsing is from deer. Observations will continue on Douglas-fir growth.

Interviews were conducted with 90 additional small forest owners to determine the factors entering their decisions in forest management. Results from 122 interviews are being coded for analysis.

Establishment of the ponderosa pine ecotype study was completed by plantings on each of five sites. The seedlings were grown from seed collected on five ecological sites, representing a wide range of site quality for the growth of ponderosa pine.

Title: IMPROVEMENT OF SOUTHEASTERN OREGON RANGES THROUGH RESEEDING AND MANAGEMENT (1959 - page 96)

Leaders: D. N. Hyder and F. A. Sneva, Agricultural Research Service. Cooperating with the Range Management Program and Department of Farm Crops

Progress: Substantial progress is being made on work plans concerned with the following problems:

a. The adaptability and performance of Nomad alfalfa as influenced by drill row spacing.

b. Adaptability and performance of six grasses as influenced by drill row spacing, (Agropyron desertorum, A. sibiricum, A. elongatum, A. inerme, A. trichophorum, and Poa ampla. Drill row spacings range from 6 to 60 inches.)



c. An evaluation of several species and strains within species of promising bunch-type grasses.

d. Crested wheatgrass response to nitrogen fertilization as related to stand density.

e. The yield and quality of dryland rye hay as influenced by nitrogen fertilization, time of harvest, and cropping frequency.

f. Effects of herbage removal on crested wheatgrass.

g. Survey of carbohydrate reserves in native and introduced grasses with descriptions of stem morphology.

h. Annual herbage yields of introduced and native forage species as related to "winter" precipitation and spring temperature.

Title: RANGE IMPROVEMENT IN SOUTHEASTERN OREGON THROUGH CONTROL OF UNDESIRABLE PLANTS (1959 - page 96)

Leaders: D. N. Hyder and F. A. Sneva, Agricultural Research Service. Cooperating with the Range Management Program and Department of Farm Crops

Progress: The influence of nitrogen fertilization on the establishment and density of big sagebrush (Artemisia tridentata) is being studied in fertilized stands of crested wheatgrass and on sprayed and unsprayed native range.

Work is also progressing satisfactorily in the following areas of investigation.

a. The influence of understory grasses upon sagebrush invasion into new seedings.

b. Species succession on sprayed range under continuously deferred grazing.

c. Selective control of big sagebrush in stands of bitterbrush.

Title: DESCRIPTION, CLASSIFICATION, AND CORRELATION OF OREGON SOILS (1959 - page 97)

Leader: Ellis G. Knox, Department of Soils. Cooperating with Soil Conservation Service

Progress: The project has included substantial amounts of additional work on the soils of range areas. New or revised series descriptions were prepared for more than 75 series in Oregon. The Oregon portion of a regional soil map of the eleven western states was revised. This produced a more satisfactory

joining with adjacent states, resulting from more uniform levels of map and classification detail and definition of great soil groups from state to state. A resource area map (almost the same as a broadly generalized soil map) of Oregon was prepared subject to review in the field. The use of grass opal in soils as an indicator of the history of soil development has been investigated.

Title: EVALUATION OF PROPERTIES AND QUALITIES OF OREGON SOIL SERIES

Leader: Ellis G. Knox. Cooperating with Soil Conservation Service

Objectives: To provide for Oregon soil series a reliable estimation of (1) properties, such as field morphology, other significant physical and chemical properties, and minerology; and (2) qualities, such as crop yield potential, fertilizer response, irrigation and drainage behavior, natural vegetation, soil stability, etc.

Progress: Soils at vegetation-soil study plots at Squaw Butte and near Jordan Valley were described and identified within the limits of present knowledge (cooperative with our W-25 contributing project). Assistance in soil description and identification was given in a study of plant ecology in southwestern Jefferson County. Predictions of monthly evapotranspiration losses of soil moisture were calculated from weather records for most of the weather stations in Oregon. Water balances, which are easily obtained from the predictions and precipitation records, will be useful both in understanding soil genesis and in interpreting soil survey information for agriculture, range management, and forestry. Other basic studies in soil morphology and genesis are included. A substantial amount of the work done under this project is performed on soils having value for range management.

Title: DEVELOPMENT OF IMPROVED METHODS OF PLANT IDENTIFICATION  
(1959 - page 93)

Leaders: J. Dennis LaRea and Kenton L. Chambers, Department of Botany and Plant Pathology

Progress: The tentative key for western Oregon has been tested with a conclusion that it is desirable to develop a single key for the entire state rather than separate keys for east and west. Descriptions have been completed for over 60 species of weed seedlings and illustrations prepared for 25 species. A series of seedlings and immature specimens of over 130 species of weeds have been grown and mounted for study.



Title: DETERMINE BEST USE AND IMPROVEMENT PRACTICES FOR FOOTHILL RANGES, BOTH OPEN AND FORESTED, IN NORTHEASTERN OREGON (1959 - page 97)

Leaders: J. A. B. McArthur, Eastern Oregon Branch Experiment Station; C. E. Poulton and R. L. Walton, Department of Range Management; J. E. Oldfield, Department of Dairy-Animal Husbandry; R. F. Keniston, Department of Forestry; and R. G. Peterson, Statistics

Progress: Studies in the grass-legume nursery under objectives 1, 2, and 3 were completed. Data are being analyzed and written up for publication. The first phase of investigation under objective 6, seasonal yield and chemical composition of native species, was completed on three sites.

The following are high points from the grass nursery study. Clippings were made to determine residual effects of fertilizer applied in the spring of 1959. Fertilization doubled grass yields in the year of application, but residual effect was much less pronounced. In all cases where nitrogen and phosphorus were applied in 1959, the yields of the legumes (Nomad alfalfa and Granger lotus) were depressed in both 1959 and 1960 at both the range readiness and hay stages. End of growing season regrowth from plots clipped at range readiness and inflorescence emergent stages of growth were similarly reduced. 1960 was very dry from June through August; and the only species showing regrowth were Nomad alfalfa, Granger lotus, Sherman big bluegrass, Whitmar beardless wheatgrass, and hard fescue. At range readiness, as judged by observations on the surrounding native range, air-dry forage yields were as follows: Hard fescue, 1065 lb/acre; creeping meadow foxtail, 830 lb.; and intermediate wheatgrass, 665 lb. At the hay stage, intermediate wheatgrass yielded 1635 lb/acre; creeping meadow foxtail, 1535 lb.; Whitmar beardless wheatgrass, 1205 lb.; timothy, 1090 lb.; with all other species tested ranging from 885 down to 585 lb. Based on forage production alone, crested wheatgrass and Sherman big bluegrass were lowest yielding at all stages of growth. These studies were conducted on a dry meadow site in the lower elevation ponderosa pine zone.

1960 yields from the native range were the same as 1959 for the ponderosa pine-Douglas fir-pinegrass site and the mixed fir forest site. The dry mountain meadow site produced about 170 lb/acre more forage in 1960 than in 1959.

Title: THE DEVELOPMENT AND APPLICATION TO FEEDING PRACTICE OF TECHNIQUES FOR MEASURING RANGE FEED CONSUMPTION AND QUALITY BY BEEF CATTLE (W-34)

Leaders: J. E. Oldfield, D. C. Church, and R. R. Wheeler, Department of Dairy-Animal Husbandry; W. A. Sawyer, J. D. Wallace, R. J. Raleigh, D. N. Hyder, and F. E. Sneva, Squaw Butte Experiment Station; and R. G. Petersen, Department of Statistics

Objectives: 1. To develop techniques for the determination of dry matter intake and digestibility of summer range forage and winter feed by beef cattle.

2. To evaluate the quality of the diet of grazing range cattle using the rumen clearance technique with fistulated animals.

3. To evaluate range forage quality through use of in vitro techniques and correlate results with in vivo observations of digestibility and dry matter intake.

4. To develop and evaluate management and nutrient supplementation practices based on the findings from the above objectives that will improve range animal performance and over-all productivity.

Progress: Work during the past year has been directed along three major lines: (1) Experimentation with the  $\text{Cr}_2\text{O}_3$  indicator in various combinations in attempts to improve regularity of excretion and recovery, (2) Use of rumen clearance technique with fistulated steers as a means of assessing quality of forage intake and of studying contamination from saliva, (3) Comparative studies using in vitro techniques to evaluate cellulose and lignin contents and cellulose digestion in various range grasses at three stages of maturity. The portion of this work being done on the range is located at the Squaw Butte Experiment Station in the sagebrush-bunchgrass zone and is carried out on both native range and crested wheatgrass seedings.

Title: THE CONTROL OF MEDUSAHEAD ON OREGON RANGES

Leaders: C. E. Poulton, Department of Range Management, and W. R. Furtick, Department of Farm Crops. Cooperating with Bureau of Land Management and Wasco County Weed Control District

Objectives: 1. Determine the present extent and severity of medusahead infestation on Oregon ranges.

2. Determine the best methods of seedbed preparation for establishing crested wheatgrass on medusahead-infested ranges.

3. Determine the rapidity of establishment and ability of the seeded grasses to compete with medusahead under the various methods of seedbed preparation.

4. Examine the usefulness of selective chemicals for the removal of medusahead the year after establishment of introduced perennial grasses.

Progress: This project is being conducted under a research grant from the Bureau of Land Management. Treatments were applied on medusahead growing in crested and intermediate wheatgrass seedings and on native range to test 16 herbicides. A perennial grass-alfalfa nursery was seeded at the Moro Experiment Station for testing of promising herbicides. One site in Wasco County was treated to control medusahead as chemical fallow for crested wheatgrass seeding. Other treatments for seedbed preparation will subsequently be applied. Plots in Wasco and Baker Counties have been sprayed with atrazine to determine effects of release on recovery of native perennial grasses. A survey of the occurrence of this weed in the State is being conducted.



Title: VEGETATION-SOIL RELATIONSHIPS AND PLANT SUCCESSION ON BRUSH-INFESTED RANGES IN OREGON (W-25)

Leaders: C. E. Poulton, W. H. C. Schallig, C. E. Conrad, P. T. Tueller, and Leroy Wullstein, Range Management Program; Lee W. Kuhn, Fish and Game Management; Ellis G. Knox, Department of Soils. Cooperating with Soil Conservation Service, Bureau of Land Management, ARS, U. S. Forest Service, Washington State University, and University of Idaho

Objectives: 1. Determine the vegetation-soil relationships which characterize the habitat types (site types) of the non-forested ranges of Oregon, where sagebrush and/or rabbitbrush create problems in forage production.

2. Determine the changes produced in vegetation and soils on these habitat types by the separate or combined effects of grazing, fire, insects, small mammals, erosion, or other disturbing factors.

Progress: In southeastern Oregon, the condition and trend methods studies were essentially completed and manuscripts are being written. Investigation of the Artemisia cana habitat type was begun, and plant successional and soils changes in the two most important habitat types (Artemisia tridentata/Agropyron spicatum and Artemisia arbuscula/Festuca idahoensis) were investigated. Climatic studies are continuing. The rodent studies at Wright's Well enclosure show a relatively low population of small mammals. A staff member in the Entomology Department has become interested in studying the harvester ant problem as it relates to range improvement and plant succession as a result of work under this project.

In the Columbia Basin, association tables were developed to show relationships among species and how these differ among habitat types. In an exploratory study, soil microbiological activity in the three main habitat types of this area was measured.

By providing ecological interpretations and characterizations of habitat types, this project contributed materially to soil correlation and established the basis for interpreting soils for range management purposes.

Title: ADAPTABILITY OF GRASSES AND LEGUMES FOR SEED AND FORAGE PRODUCTION IN NORTHEAST OREGON

Leaders: F. V. Pumphrey and J. A. B. McArthur, Eastern Oregon Branch Experiment Station; J. R. Cowan and H. H. Rampton, Department of Farm Crops; and L. D. Calvin, Department of Statistics

Objectives: 1. Adaptation, seed, and forage potential of strains, varieties, and species of grasses and legumes.

2. Cultural practices which improve seed and forage production.

3. Rotation management in which the rotation contains seed and forage producing grasses and legumes.

Progress: Yields of grass were determined in two nurseries located in different microclimates in Union County. Pounds per acre oven-dried forage produced under 10-inch rainfall were: tall wheatgrass (Agropyron elongatum), 940 lb.; crested wheatgrass (A. desertorum), 680 lb.; pubescent wheatgrass (A. trichophorum), 680 lb.; brome grass (Bromus inermis), 560 lb.; intermediate wheatgrass (Agropyron intermedium), 540 lb. All legumes and other grasses planted have failed to maintain sufficient stand so that yields can be determined. The later-maturing species were more productive than the early-maturing species on sub-irrigated land. Species producing over 6000 lb. of oven-dried forage per acre were: tall wheatgrass, 7800 lb.; reed canarygrass (Phalaris arundinacea), 7580 lb.; intermediate wheatgrass, 6800 lb.; and tall fescue (Festuca elatior), 6190 lb.

Title: IMPROVEMENT OF RANGE LIVESTOCK PRODUCTION ON THE OREGON HIGH DESERT AREA THROUGH NUTRITION AND MANAGEMENT RESEARCH  
(1959 - page 99)

Leaders: Robert J. Raleigh, Joe D. Wallace, and W. A. Sawyer, Squaw Butte Experiment Station; J. R. Haag and C. E. Turnbow, Department of Agricultural Chemistry; J. E. Oldfield, D. C. Church and R. R. Wheeler, Department of Dairy and Animal Husbandry

Progress: Research is progressing under the following work plans:

1. Performance of Hereford range cattle as influenced by periodic copper glycinate injections and/or oral administration of cobalt bullets: Thus far, experimental treatments have exhibited no significant influence on weight gains in the test animals.

2. The influence of two appetite stimulants, an antibiotic supplement, and early weaning on the post-weaning performance of Hereford calves: Weight gains or feed efficiency were not materially influenced by appetite stimulants. Calves receiving antibiotics gained 0.30 lb. more per day than the controls, with the main response occurring during the first three weeks of the study. Conclusions have not been reached on the effect of early weaning versus normal weaning.

3. The influence of one and two copper and iron injections on body weight changes and hematologic volume of male and female calves: Female calves had consistently higher hemoglobin values than the males at each time of bleeding. Time had a highly significant effect on hemoglobin values with these being higher at birth and slightly lower at each subsequent period. The interaction of time and iron was also highly significant for hemoglobin and followed the same trend as for time alone. The same treatments were significantly different for packed cell volume data. The over-all analysis of the data revealed no significant differences in gain with respect to treatments. Analysis of the data, using time as the split-plot, showed the difference due to sex to be



significant. Observation of the data showed that steer calves consistently outgained the heifer calves up to 15 weeks of age, but in the period from 15 to 25 weeks the heifers outgained the steers.

4. The effect of feeding crushed salt and block salt on intake and body weight gains of yearling steers during the summer grazing season: Differences in gain with respect to type of salt fed were not significant in the trial conducted between May 2 and August 23. Salt consumption was about the same for both block and crushed, with animals on the latter type of salt consuming 15.4 lb. per head during the season. Animals showed no particular preference or requirement for more salt at specific times of the grazing period with no variation in consumption from week to week.

5. The use of the "rumen clearance" technique in measuring the qualitative intake of grazing animals: Rumen fistulated steers were used. Indications are that a single composite sample, properly taken, would be representative of the rumen contents. Samples from the rumen were consistently higher in both ash and protein content than from the parent forage where the latter was obtained by simulating "normal" grazing conditions. Mechanically, this technique is workable. The possibility of developing a correction factor for application when forage of specific types is under investigation is suggested.

6. The application of  $\text{Cr}_2\text{O}_3$  dispersed in cellulose for determining the dry matter intake and digestibility of the grazing animal: This experiment was conducted on crested wheat seedings. Data are being analyzed.

Title: TESTING OF NATIVE, INTRODUCED, AND IMPROVED SPECIES OF GRASSES, LEGUMES, AND OTHER GENERA FOR FORAGE AND SEED PRODUCTION AND OTHER UTILITY PURPOSES (1959 - page 100)

Leader: H. A. Schoth, Department of Farm Crops and Agricultural Research Service. Cooperating with Forage and Range Research Branch, Crops Research Division, ARS

Progress: Work is continuing on promising strains of Lolium, Dactylis, Festuca, Phalaris, Poa, Bromus, Phleum, Arranatherum, Sanguisorba, Trifolium, and Lotus. Some accessions of Poa, Festuca, Arranatherum, and Phalaris are on increase for the production of "Foundation" seed.

Title: CULTURAL, CHEMICAL AND BIOLOGICAL WEED CONTROL IN THE COLUMBIA BASIN

Leaders: Dean G. Swan, Pendleton and Sherman Branch Experiment Stations; W. R. Furtick, Department of Farm Crops; William E. Hall, Sherman Station; Merrill Oveson, Pendleton Station; W. W. Chilcote, Department of Farm Crops; and Curtis Mumford, Department of Agricultural Economics

Objectives: 1. Develop new or improved methods of selective and non-selective control of weeds on crop and non-crop land in the Columbia Basin of Oregon.

2. Study of factors which might influence weed control measures.

Progress: While this branch station project is aimed primarily at Columbia Basin crop land problems, it is developing knowledge useful in the control of annual weeds on rangeland. Simazine and atrazine gave good cheatgrass control at early dates of application. Atrazine and diuron controlled red-stemmed filaree. All chemicals tested gave excellent fiddleneck control. A 1-pound rate of simazine, applied at three dates, was found to give good cheatgrass control on the first two dates of application. Experiments are being conducted on chemical summer fallow, a treatment which may have some application in the preparation of seedbeds for range rehabilitation. Other experiments are being conducted on chemical weed control in alfalfa. Diuron is effective for some weeds as was simazine when used as a dormant spray. Other tests of interest to range people include work on the control of wild oats and Canada thistle.



## SOUTH DAKOTA

Title: MINERAL REQUIREMENTS AND MINERAL SUPPLEMENTS FOR CATTLE AND SHEEP  
(1959 - page 101)

Leaders: L. B. Embry, A. E. Dittman, G. F. Gastler and O. E. Olson

Progress: Steer calves are being wintered at the Range Field Station, Cottonwood, and the North Central Substation, Eureka, with rations composed of prairie hay and supplements. Mineral supplements are being force-fed in the protein supplement to one group of cattle and offered free-choice to another group. The value of an antibiotic is being tested in the protein supplement and in the free-choice mineral supplement. Prior to the start of the wintering trial the calves were used in a one month trial to test the value of high levels of antibiotics with 20 and 40% protein supplements following shipping. Feeding 350 mg. of Aureomycin daily generally improved rate of gain following shipping with the 40% protein supplement plus the antibiotic giving the best results. During the winter feeding trial, calves fed the antibiotic have gained slightly faster. Calves offered mineral supplements free-choice have gained as well as those force-fed mineral supplements. In a pasture trial, free-choice trace mineral salt appeared as adequate as a cobalt bullet in meeting the cobalt requirements of yearling steers grazing native prairie pasture if supplemental cobalt was needed.

Title: PROTEIN AND ENERGY REQUIREMENTS OF BEEF CATTLE (1959 - page 101)

Leaders: L. B. Embry, F. W. Whetzal, W. B. McGillick, D. H. Reid,  
M. A. Hoelscher, L. D. Kamstra and R. J. Emerick

Progress: Yearling steers were fed rations composed of 20% brome grass hay and 80% concentrates which contained 9.6, 10.7, 11.8 and 12.9% protein. Rations with 10.7% protein gave as good gains and feed efficiency as rations with higher levels of protein. Various feed additives (stilbestrol, dynafac and diallylstilbestrol) did not affect the protein requirement, and stilbestrol was the only additive which improved the performance of the steers. In other trials with high-concentrate rations containing 20% ground alfalfa hay, dynafac but not diallylstilbestrol appeared to improve rate of gain and feed efficiency. When rations contained 50% ground alfalfa hay, a slightly greater gain was obtained with ground shelled corn than with rolled shelled corn. Steer calves previously wintered for gains of about 0.25 to 1.0 lb. daily by feeding different levels of protein and energy were fed during the summer on an all-forage ration composed of low-moisture (40%) alfalfa silage and then fed a fattening ration. The system of wintering had no effect on summer or fattening gains or carcass grades. The steers making the lower wintering gains required more days on the fattening rations. Low-moisture (40%) alfalfa silage was stored in a concrete stave silo with storage loss of dry matter of only 4.2% during a 78-day period. Feeding value of the 40% moisture silage was greater than for 60% moisture alfalfa silage. Feeder lambs have been successfully full-fed a ration with 20-25% ground alfalfa hay and 75-80% concentrates. Feed efficiency has been about 500 pounds or less

per 100 pounds of gain in some instances. Bacitracin and an enzyme, Zymo-Pabst, appeared to improve gains and feed efficiency while chlortetracycline and an enzyme product, Rum-A-Lak, did not. Three mg. stilbestrol implants improved gains more than did feeding two mg. of stilbestrol daily with wethers responding more than ewes.

Title: NUTRITIVE VALUE OF GRASSES AND HAYS OF THE NORTHERN GREAT PLAINS  
(1959 - page 102)

Leaders: L. B. Embry, F. W. Whetzal, A. L. Musson, G. F. Gastler and  
O. E. Olson

Progress: Winter feeding trials with steer calves have been continued for another year to determine feeding value and storage losses of prairie hay stored in open stacks for different numbers of years. Gains have been quite variable between years and between hays. Well-made stacks of loose hay have suffered less spoilage than stacks of either round or rectangular bales.

Title: THE APPLICATION AND DEVELOPMENT OF EQUIPMENT FOR CONSERVATION  
FARMING IN SOUTH DAKOTA

Leader: Donald D. Hamann

Objectives: 1. To develop suitable equipment for pasture renovation and conservation. (a) Design and develop a pasture furrower for soil and water conservation. (b) Adapt and develop equipment for renovation, tillage, seeding, and fertilizing existing pastures and rangeland.

2. To test and develop equipment for minimum tillage in South Dakota. (a) Test and develop equipment for wide-row spacing and wheel track planting. (b) Test and develop equipment for plow-plant, lister-plant, disk-plant, and similar possible minimum tillage practices.

3. To investigate seed planting equipment and if possible design more efficient planting machines. (a) Develop more accurate equipment to plant some of our hard-to-control seeds such as sorghum. (b) Develop a universal planter for grains, grasses, legumes, etc. (c) Reduce seed damage caused by our present equipment.

Progress: An experimental pasture furrowing machine was tested under various conditions. Although the basic design proved quite satisfactory, need for redesign and refinement was evident. A second machine is now being constructed into which these changes are incorporated. Equipment for ridging and planting row crops on the south side of these ridges for faster germination has been constructed and used during the past growing season. Soil temperatures were recorded, and results showed temperatures on the south slope were warmer during the daylight hours at seed depths but large differences were not noted during the dark hours.



Title: LEVELS AND LENGTHS OF TIME OF CONCENTRATE FEEDING FOR WINTERING  
BRED RANGE EWES UNDER RANGE CONDITIONS (1959 - page 103)

Leaders: J. K. Lewis, F. R. Gartner, L. B. Embry and W. R. Trevillyan

Progress: Ewes grazing on high-condition deferred winter range were fed the following protein supplements daily: (1) 1/3 lb. 40% winterlong (November 1 to lambing), (2) 1/3 lb. 20% winterlong, (3) 1/3 lb. 40% last 6 weeks of gestation, or (4) 2/3 lb. 20% winterlong. One hundred ewes were permanently allotted to each winter supplemented lot and to each summer grazing treatment in 1952, so that winter and summer treatments were balanced in each lot. Replacement ewes have been chosen (at about 18 months age) from the lots in which they were produced. Results in 1960 were as follows:

| <u>Winter Lot</u>                    | <u>1</u> | <u>2</u> | <u>3</u> | <u>4</u> |
|--------------------------------------|----------|----------|----------|----------|
| Grease fleece weight, lb.            | 11.3     | 11.3     | 10.6     | 11.9     |
| Lamb crop born of ewes bred, %       | 116.2    | 124.3    | 129.3    | 136.0    |
| Lamb crop weaned of ewes bred, %     | 104.1    | 108.1    | 112.0    | 120.0    |
| Lamb weaning weight, singles, lb.    | 87.4     | 90.0     | 86.9     | 90.8     |
| Lamb weaning weight, twins, lb.      | 73.9     | 72.5     | 70.3     | 73.4     |
| Lamb weight weaned per ewe bred, lb. | 85.2     | 89.9     | 92.0     | 99.2     |

Response to winter supplemental feeding is strongly conditioned by summer grazing intensity. Year to year variations have been large.

Title: THE CUMULATIVE EFFECTS OF VARIOUS SUMMER GRAZING TREATMENTS ON  
RANGE EWE PRODUCTION AND ON THE NATIVE VEGETATION IN NORTHWESTERN  
SOUTH DAKOTA (1959 - page 104)

Leaders: J. K. Lewis, F. R. Gartner, L. B. Embry and W. R. Trevillyan

Progress: An intensity of grazing study has been conducted at Antelope Range since 1950. In 1952, one hundred ewes were permanently allotted to heavy, moderate and light grazing and to each winter feeding treatment in order to balance winter and summer treatments in each lot. The summer grazing season has been from about May 1 to November 1. Replacements have been selected from the lots in which they were produced. Results in 1960 are as follows:

| <u>Summer Grazing Intensity</u>        | <u>Heavy</u> | <u>Moderate</u> | <u>Light</u> |
|--|--------------|-----------------|--------------|
| Stocking rate, acres per ewe per month | 0.42         | 0.68            | 0.87         |
| Lamb crop born of ewes bred, %         | 119.2        | 130.3           | 130.0        |
| Lamb crop weaned of ewes bred, %       | 106.1        | 108.1           | 119.0        |
| Lamb weaning weight, singles, lb.      | 86.0         | 90.9            | 89.7         |
| Lamb weaning weight, twins, lb.        | 66.1         | 74.0            | 75.0         |
| Lamb weight weaned per ewe bred, lb.   | 85.0         | 90.6            | 99.2         |

Summer grazing response is strongly conditioned by winter plane of nutrition. Year to year variation has been large.

Title: SUMMER GRAZING OF BEEF COWS FOR CALF PRODUCTION (1959 - page 105)

Leaders: J. K. Lewis, F. R. Gartner, O. E. Olson and Donald Woodford

Progress: Eighty steer calves were allotted at random to the treatments described below. One group of calves was wintered in Brookings in dry lot with five different grubicides. A second group was range-grazed with 2 1/2 pounds per head daily of a 40% protein supplement. For the first 28 days these calves were fed four pounds of a 20% protein supplement in two groups--with high level antibiotics and without. A cobalt bullet was placed in the rumen of one-half of the steers in each group at each location in mid-winter. In early May, the 80 calves were placed on replicated pastures that have been grazed heavily, moderately or lightly from early May to late November since 1942. The antibiotic treatment had no effect on total winter gain. Brookings calves used gained 1.85 pounds per head daily during the grub treatment and 1.13 pounds during the whole winter, while range calves gained 0.96 pounds ( $P < .01$ ). Yearlong gains were 0.83 and 0.78 pounds respectively for the Brookings and range calves ( $P < .05$ ). Summer gains were proportional to intensity of use but were affected by percent of draws which provided more nutritious forage most of the season. Cobalt bullet calves gained the same as those receiving trace mineral salt. However, there may have been a small response on light grazing in replication 1 and moderate grazing in replication 2 as indicated by a highly significant rep x grazing rate x cobalt interaction for yearlong gain. Intensive utilization studies were made.

Title: SOCIAL AND ECONOMIC FACTORS ASSOCIATED WITH SUCCESS OR FAILURE OF FARM AND RANCH OPERATIONS ON INDIAN RESERVATIONS IN SOUTH DAKOTA (1959 - page 105)

Leaders: V. D. Malan, A. R. Clark and E. L. Schusky

Progress: Interviewing of ranchers and non-ranchers on the Pine Ridge Reservation was completed, the data was analyzed, and a preliminary report on the non-ranching population has been written and the manuscript has been submitted for approval. The final report comparing the ranching with the non-ranching samples is now being prepared. Findings of the preliminary report are summarized below.

1. The need of an economic development program.
2. The program should be flexible enough to meet the needs of each community.
3. Those with the greatest poverty demonstrate the least aspiration.
4. Their aspirations were not in all cases in accord with their qualifications.



Title: HYDROLOGIC STUDIES OF SMALL WATERSHEDS IN SOUTH DAKOTA

Leader: John L. Wiersma

Objectives: 1. To provide and secure basic data in the design of small watershed structures and to incorporate their relationship in soil and water practices.

2. To determine the adequacy of available data on rainfall amounts and intensities.

3. To prepare hydrographs for small agricultural watersheds for use in design of water control structures.

4. To obtain the characteristics of ground water flow for use in design of earthen water control structures and in mechanical means of ground water extraction.

Progress: Instrumentation for the present has been completed on the one watershed under observation. Rainfall and runoff data were gathered for this watershed. Rainfall in general was near normal in the area, but no high-intensity storm was experienced. Runoff was low except for snow melt water which was near normal. No attempt has been made to analyze data as yet because of lack of runoff. Some work was initiated in the laboratory to design a wind-recording instrument to be used for this type work. Wind plays an important role in snow runoff water. A watershed may gain or lose snow to an adjacent area depending upon wind direction and intensity. Also, extent and size of drifts affect amount of runoff. Soil and air temperature at snow melt time also regulates infiltration rates and amounts.

## TEXAS

Title: THE CHEMISTRY OF THE POISONOUS RANGE PLANTS OF TEXAS  
(1959 - page 106)

Leaders: Bennie J. Camp, Robert Pigeon and Ted Shaver, Department of Biochemistry and Nutrition; J. W. Dollahite, Department of Veterinary Physiology and Pharmacology; Charles Bridges, Department of Veterinary Pathology; and Charles Livingston, Ranch Experiment Station

Progress: Guajillo (Acacia berlandieri) - N-methyl beta phenylethylamine has been isolated from guajillo, and when the synthetic form of the compound is administered to sheep, it produces demyelination of brain nerve tissue. The compound when injected intravenously into sheep produces bradycardia, increased rate of respiration, elevated blood pressure, and increased muscular contraction. A second sympathomimetic amine related to N-methyl beta phenylethylamine has been isolated from guajillo.

Shin Oak (Quercus havardi) - This plant is abundant in tannins. The tannins have been isolated from shin oak and when orally administered to rabbits, produce a toxic condition terminating in death.

Broomweed (Gutierrezia species) - An abortifacient has been isolated from this plant, and when injected intravenously into pregnant rabbits, goats, and cows induces abortion.

Title: CONTROL OF NOXIOUS BRUSH ON TEXAS RANGELANDS (1959 - page 107)

Leaders: R. A. Darrow and R. H. Haas, Department of Range and Forestry. Cooperating with E. E. Hughes and E. D. Robison, Spur Substation; H. L. Morton, Agricultural Research Service and T. H. Silker, Texas Forest Service

Progress: Extensive tests of granular and pelleted herbicides have been made in broadcast, strip and individual tree applications for control of post and blackjack oaks, live oak, persimmon and juniper. For control of post and blackjack oak, broadcast applications of fenuron pellets are recommended at a new rate of five to six pounds active fenuron per acre.

Basal spray application of 2,3,6-TBA and related compounds was found to be effective in control of common persimmon. Granular or pelleted fenuron and 2,3,6-TBA in individual plant applications are effective in control of red-berry juniper, common persimmon and Mexican persimmon.

Preliminary tests of tractor-mounted mistblower equipment were made for control of hardwood in pine-hardwood areas.

A 3-year aerial spray program in comparison of herbicides for control of sand shinnery oak was established.

Aerial spray tests for control of perennial broomweed were initiated, together with an intensive program of foliage spray applications to evaluate suitable conditions for control. An intensive series of repeated broadcast spray applications was established using 2,4-D ester and amine to secure a satisfactory recommendation for control of Macartney rose.

Studies were initiated on the rate of decomposition of radioactive 2,4,5-T on forage grasses and on the effects of humidity and temperature on the absorption and translocation of radioactive 2,4,5-T in mesquite and whitebrush.



Title: EFFECT OF FERTILIZER TREATMENTS ON RANGE FORAGE PRODUCTION AND VEGETATIONAL COMPOSITION (1959 - page 108)

Leaders: R. A. Darrow, Department of Range and Forestry; Judd Morrow, formerly Department of Range and Forestry; A. G. Caldwell, Department of Agronomy; and W. J. McBride, Encino Field Laboratory. Cooperating with King Ranch, Inc. and Monsanto Chemical Company

Progress: Field work and analysis of data have been completed. Data are being summarized and prepared for publication.

NPK fertilizers applied in a 2 x 3 x 3 factorial experiment in sandy Coastal Plain soil showed no significant increase in total forage three years after treatment. Applications of N with K or P tended to reduce total herbage production. Additions of P reduced the yields of desirable grasses and favored growth of the less desirable Brachiaria ciliatissima on both grazed and ungrazed areas.

Title: THE EFFECTS OF BRUSH CONTROL ON WILDLIFE IN THE RIO GRANDE PLAINS (1959 - page 108)

Leaders: Richard B. Davis, Robert L. Spicer, Jack M. Inglis and Van Klett, Department of Wildlife Management; Rural R. Bell, Veterinary Parasitology; Robert A. Darrow, Department of Range and Forestry; Curtis S. Godfrey, Department of Agronomy; Ralph L. Hanna, Department of Entomology; and Walter H. Thames, Jr., Department of Plant Physiology

Progress: 1. Report on extent and kind of brush control. Report being prepared for publication by the Texas Game and Fish Commission. About 28 per cent of the Rio Grande Plain has experienced some brush control. Of this, about 82 per cent has been by chaining or chopping; 13 per cent by rootplowing with seeding to introduced grasses. The deep fertile soils supporting mesquite forests have experienced most control, the deep fine sands the least. There has been a gradual shift from chaining or chopping to use of rootplowing with seeding. Ranches of cooperators with the programs of Soil Conservation Districts average three times the size of non-cooperator ranches, but have controlled brush on about the same proportion of their holding as the non-cooperators. SCD cooperators have been the innovators of new brush control practices, but non-cooperators apply tested practices. Rootplowing appears to have the most lasting effects in control of brush, but brush regrowth occurs after all types of control. Success of reseeding with grasses could not be evaluated in this survey, as available criteria for measuring success were not uniform or sufficiently objective. Effects of brush control practices on wildlife could not be evaluated by the methods of the survey because the available data either were based on hearsay or on incomparable types of records.

2. Report on history of wildlife and habitat. Report being prepared for publication by the Texas Game and Fish Commission. Scanning of more than 250 books, many bibliographic indexes and many old journals resulted in the discovery of the narrative diaries of 36 people who traversed the Rio Grande Plains during the periods 1675-1747, 1821-1861 and 1875-1900. Their comments about vegetation observed at identifiable places were compiled.

From this data, it was concluded that mesquite and other "brush" species were present in open to very scattered stands on the uplands during the first period and had increased only slightly during the second. However, during the third period, brush density was rapidly approaching that found on undisturbed sites at present. Chaparral was not at all uncommon in river and creek bottoms even during the earliest period.

The increase in density was due to increase in number of stems in situ, and not to an invasion except as perhaps some species invaded the uplands from the bottoms. Consideration of the data indicates that the increase was exponential. This change influenced deer, turkey and antelope in various ways because it involved a major shift in habitat conditions.

3. Progress in simultaneous studies. The co-workers listed constitute the membership of a committee at Texas A & M on ecosystem research on rangelands. Membership is voluntary, based on recommendations of respective department heads. Objectives and methods for attacking the ecosystem from the team approach have been discussed in a series of meetings, and the members are presently engaged in working up proposals for their respective fields of interest. Prospects for obtaining an adequate study are much improved over those last year, but prospects for obtaining funds for research on topics other than vertebrates have dimmed considerably.

4. Progress on study of food habits of white-tailed deer throughout the Rio Grande Plain. Study of rumen contents of deer taken in all months from both root-plowed and brushy ranges on seven pairs of study sites suggest strongly that deer eat little grass, and use about the same species of plant foods on both root-plowed and brushy ranges. Deer seem to spend much less time on root-plowed lands than in areas adjacent to them. Size of plowed areas, degree of weediness, and extent of brush regrowth all seem to be factors in the relative use by deer of root-plowed areas, however.

Title: PREVENTION AND CONTROL OF ABORTIONS IN GRAZING CATTLE CAUSED BY EATING PERENNIAL GUTIERREZIA SPECIES (1959 - page 110)

Leaders: J. W. Dollahite and T. J. Allen, Animal Disease Investigations, W. Texas, Marfa; B. J. Camp and Ted N. Shaver, Department of Biochemistry and Nutrition; and Eugene E. Hughes, Substation #7, Spur, Texas

Progress: A toxic compound has been isolated from this plant. When it is injected intravenously into pregnant rabbits, goats and cows, it produces death or abortion. Natural biological die-off of Gutierrezia species in 1960



nullified the results of control trials. Insects collected from the dead plants were identified by the Department of Entomology. Several new species and possibly one new genus of insects were identified.

Title: THE REPRODUCTIVE CHARACTERISTICS OF ECOTYPE SELECTIONS OF ANDROPOGON BARBINODIS, A. SACCHAROIDES, AND BOUTELOUA CURTIPENDULA AS RELATED TO THEIR POTENTIAL USE IN REVEGETATION OF DEPLETED RANGE AREAS (1959 - page 112)

Leaders: Frank W. Gould, W. C. McCully and Zarir Kapadia, Department of Range and Forestry, and E. C. Holt, Department of Agronomy

Progress: In the report of last year, reference was made to three general habit types of Bouteloua curtipendula, rhizomatous, bunch, and stoloniferous. Considerable additional information has been obtained concerning "cytological races" of Mexican plants of the stoloniferous and rhizomatous types. Preliminary cytological data now has been obtained on Mexican plants with extremely short rhizomes referred to the category of "knotty base." At least one cytological race of knotty base type has a high chromosome number ( $2n=80+$ ) with no pairing of the chromosomes evident in pollen meiosis. In P.M.C. Div. I, all of the chromosomes regularly go to one pole. Continued studies are being made on the complex hybrid-polyploid-aneuploid series of plants of the B. curtipendula complex of Mexico.

Title: A SYNOPSIS OF THE PLANTS OF TEXAS (1959 - page 113)

Leaders: F. W. Gould and O. E. Sperry, Department of Range and Forestry, and Soil Conservation Service personnel

Progress: The manuscript for the publication tentatively titled "A Synopsis of the Plants of Texas" has been completed. This material is expected to be published in 1961 under the title of "Texas Plants, A Checklist and Ecological Summary."

Title: ESTABLISHMENT AND MANAGEMENT OF GRASSES AND LEGUMES (1959 - p. 113)

Leaders: E. C. Holt, J. A. Long and P. R. Johnson, Department of Agronomy

Progress: Establishment studies at Denton, Texas, continued for several years show that species differ greatly in their emergence ability and in response to time of seeding. Sideoats grama emerged equally well under either late winter or spring seeding and produced more established plants than other species. Blue panic emerges rapidly and definitely responds better to warm-soil conditions. Rolling the seedbed following seeding improved establishment slightly, but seed treatments consisting of  $KNO_3$  or chilling did not influence germination or establishment.

Total forage production has not been influenced significantly with herbicidal weed control, but weeds (dock) made up 28% of the forage in untreated plots at Tyler, Texas, in 1960. One-half pound of 4(2,4-DB) gave complete control of dock, and weeds made up only 5% of the forage from plots treated with one-half pound per acre of 4(MCPB). Bullnettle which is not susceptible to 2,4-D and cannot be successfully destroyed by mowing has been significantly reduced in pastures at Tyler using a solution of four pounds of Amitrole in 100 gallons of water and spot treating with one-half pint of the solution per plant.

Title: GROWTH AND MANAGEMENT OF SELECTED FORAGE SPECIES (1959 - page 114)

Leaders: E. C. Holt and R. D. Staten, Department of Agronomy

Progress: Total yields of Kleingrass and Dallisgrass were not greatly influenced by either height or frequency of clipping in the first year of study. The only treatment which resulted in increased growth and forage production was with the least severe defoliation of Kleingrass. The final cumulative growth of Dallisgrass crowns and roots was essentially the same for all treatments and exceeded the initial weight by only 1,400 pounds per acre. More basal leaves were present with less frequent harvesting and the greater stubble heights, but these differences were not related to plant growth. Both crown and root weights decreased following clipping even with the greater stubble heights. However, weight losses were regained before the next clipping.

Title: CONTROL OF WEEDS AND IMPROVEMENT OF GRASSES ON RANGES IN WEST TEXAS (1959 - page 115)

Leaders: Don Huss and C. L. Leinweber, Department of Range and Forestry; Leo Merrill, Substation 14, Sonora; P. E. Hildebrand, Department of Agricultural Economics; and E. J. Compton, University of Texas representative

Progress: Trends have been the same as reported in 1959. Tobosa grass utilization increases with increase of cattle stocking rate under yearlong grazing and decreases with increase of sheep. Tobosa grass utilization decreases with deferred grazing regardless of cattle stocking rate. It appears that bitterweed decreases in abundance with deferment during the establishment period of September, October and November. Ewe death losses attributed to bitterweed for the winter of 1960 were 18.5% among the sheep alone on pasture as compared to 7.1% among sheep grazing with cattle. The grazing intensity was 25 animal units per section-yearlong. Deferred rotation resulted in the highest 3-year average of livestock production per acre as compared to all other treatments. Prickly pear was effectively controlled through individual applications of 8# 2,4,5-T low-volatile ester in 100 gallons of diesel oil. Estimated cost for average densities is \$4.66 per acre.



Title: THE RESPONSE OF DESIRABLE SELECTIONS OF NATIVE GRASSES TO CLIPPING AND GRAZING TREATMENTS ON THE SOUTHERN HIGH PLAINS OF TEXAS (1959 - page 119)

Leaders: Chester C. Jaynes, Texas Technological College and Substation No. 8; Wayne G. McCully, Department of Range and Forestry; Harvey Walker, Substation No. 8; Clark Harvey, Department of Agronomy, Texas Technological College and Substation No. 8; Ralph Durham, Department of Animal Husbandry, A. W. Young, Department of Agronomy, and Gerald W. Thomas, Dean of the School of Agriculture, Texas Technological College

Progress: Data are being collected from dryland and irrigated plots of selected strains of Panicum virgatum, Bouteloua curtipendula, Leptochloa dubia, Setaria macrostachya, and Andropogon barbinodis. Clipping heights range from 2 inches to 12 inches above the soil. On dryland, selected strains of L. dubia and S. macrostachya have continued to deteriorate when clipped at a 2-inch height.

In irrigated plots of P. virgatum, clipping height was kept constant at six inches above the soil. The total yield of crude protein per acre from plots clipped every time two inches of new growth had formed was 850 pounds. This yield was 60% more than was obtained from plots clipped each time four inches of new growth was formed. The lowest yield of crude protein was from plots harvested when the first seeds were mature. At this stage the forage, without seed, contained 1.64 per cent crude protein. The total yield of protein per acre was 145 pounds.

Title: EVALUATION OF POTENTIALLY DROUTH RESISTANT GRASSES FOR THE SOUTHWEST (1959 - page 116)

Leaders: W. G. McCully, R. A. Darrow and F. W. Gould, Department of Range and Forestry; R. G. Reeves, Department of Genetics; J. N. Pratt, Substation No. 15; C. Jaynes, Substation No. 8 and Texas Technological College; L. B. Merrill, Substation No. 14; W. R. Cowley, Substation No. 15; B. C. Langley, Substation No. 20; M. J. Norris, Substation No. 23; Tom Allen, Animal Disease Investigations; Earl Burnett, Soil and Water Conservation Research Division, and E. B. Hudspeth, AERD

Progress: A selection of sideoats grama collected in Mexico in cooperation with the Agricultural Research Service of USDA was released under the varietal name "Premier." This new variety of sideoats has been well received by a number of commercial seed growers in Texas. It is recommended for use in northwestern Texas.

Evaluation of several species and species complexes is being continued toward the establishment of commercial varieties in these materials and to facilitate their possible use in breeding.

Title:       VEGETATION CONTROL IN TEXAS HIGHWAYS

Leader:     W. G. McCully, Department of Range and Forestry. Cooperating with Texas Transportation Institute, Texas Engineering Experiment Station and Texas Highway Department

Nature of Research: Maintenance and construction engineers are aware of the advantages of a vegetative cover on the unpaved portions of the highway right-of-way. This project is designed to evaluate plant materials and methods of establishment. Also, the control of vegetation, primarily Johnsongrass and Bermudagrass, in asphalt pavement is being studied.

Progress: In a study conducted on both sandy and clay back slopes in the vicinity of College Station, it was found that green sprangletop and buffelgrass gave better stands than cane bluestem, plains bristlegrass or Gordo bluestem. Establishment, but not germination, was enhanced by the application of a nitrogen-phosphorus fertilizer. Mechanical tillage of the heavier soil seemed to improved the soil-plant-water relationships and gave better stands than untilled slopes.

A number of herbicides were disked for both pre-paving and post-paving application. Both TCA and substituted urea materials gave good control of the unwanted vegetation in asphalt pavements. TCA is preferred since desirable vegetation along the right-of-way was affected adversely by spray solutions containing substituted ureas.

Title:       THE INFLUENCE OF GRAZING MANAGEMENT SYSTEMS ON VEGETATION COMPOSITION AND LIVESTOCK REACTION (1959 - page 117)

Leaders:    Leo B. Merrill, Department of Range Management, Substation No. 14, Sonora, Texas. Cooperating with C. L. Leinweber, Department of Range and Forestry, W. T. Hardy, Substation No. 14, and E. B. Keng, Soil Conservation Service, Sonora

Progress: Under continuous grazing use, moderately grazed pastures have shown continued range improvement during average rainfall conditions of approximately 22 inches per year. Heavily grazed pastures have shown no improvement but rather have experienced a slight decline. The pasture grazed with cattle, sheep and goats at the heavy grazing rate has the greatest ground cover of curly mesquite grass of any pasture in the study. This appears to be the normal reaction of increased vegetation in the Edwards Plateau area. Lightly grazed pastures have not shown material range improvement and resulted in very low pounds of animal gains compared to moderately or heavily grazed pastures.

Moderately grazed deferred rotation pastures through increased carrying capacity produced greater amounts of livestock products per acre than the continuous heavily grazed pastures in 1960. Three pastures in the four-pasture deferred rotation system responded very satisfactorily to the increased grazing (an attempt to reach proper use), but the pasture grazed



intensively in July, August, September and October made little recovery during the winter rest period and following a very dry spring is shorter than desirable for best plant response or for maximum water holding ability.

Deer populations have changed little since the 1959 report. They still concentrate on deferred rotation pastures and on moderately and lightly grazed areas under continuous use. They avoid heavily grazed pastures except where cattle are grazed alone.

Rocky areas which were ripped and root-plowed showed excellent recovery of desirable native vegetation and heavy grazing use was obtained from the planted species, sorghum alnum and blue panic. The area carried an average of 60 animal unit years per section, but the grazing was obtained by intensive use in spring and late fall and rest for the remainder of the year.

Title: PLACE OF KEY HARDWOOD BROWSE SPECIES AS INDICATORS OF PROPER USE OF FORAGE BY CATTLE AND/OR DEER IN PINE-HARDWOOD PASTURES OF EAST TEXAS (1959 - page 121)

Leader: T. H. Silker, Texas Forest Service. Cooperating with Substation No. 22

Progress: Although plant use and composition data are not yet summarized and analyzed, it appears the following may hold for the heavily-used woods pastures: (1) Heavy late-summer mortality of pine regeneration where range condition is kept in weed or carpet grass stage by overuse, (2) periodic heavy winter browse use of pine regeneration and saplings, primarily by deer on heavily stocked deer range, (3) preferred and near-exclusive browsing of shortleaf regeneration over loblolly, attributed to lower fibre content of short-leaf pine browse, and (4) heavy damage to desirable hardwood regeneration by fall browsing and to saplings by winter and early spring browsing.

Title: FITTING IMPROVED SOIL, WATER, CROP, AND LIVESTOCK MANAGEMENT PRACTICES INTO CONSERVATION FARMING SYSTEMS FOR THE TEXAS BLACKLAND (1959 - page 122)

Leaders: R. M. Smith, R. C. Henderson, L. E. Clark, R. J. Hervey, and E. D. Cook, Substation No. 5; Ralph H. Rogers, USDA-FERD, Agricultural Economics and Sociology Department; John H. Jones, Department of Animal Husbandry; and John E. Adams, Agricultural Research Service, Temple, Texas

Progress: One more year (1960) of seasonal **grazing results** was obtained, with 95 pounds of steer gain per acre.

Title: DISTRIBUTION AND CONTROL OF POISONOUS PLANTS ON TEXAS RANGELANDS  
(1959 - page 123)

Leaders: Omer E. Sperry and George W. Sultemeier

Progress: Bitterweed was most susceptible to 2,4-D when soil moisture was above permanent wilting percentage. Kill was unsatisfactory when it was sprayed at a time when soil moisture was near or below wilting percentage. Kill ratios were further reduced when soil moisture was low at time of spraying and followed within 60 days by good rainfall. 2,4-D ester at a rate of one pound per acre was the most satisfactory control treatment.

Perennial broomweed appears highly susceptible to herbicide when applied under optimum moisture and growth conditions. Little or no susceptibility or only top kill resulted when it was sprayed under adverse growth conditions.

Mescal bean reaction to fenuron continued into the second and in some cases into the third growing season. Basal stem treatments with formulations of 2,4,5-T and other test herbicides in diesel oil have resulted in satisfactory kills when applied in summer after good rainfall.

Title: EVALUATION OF CHEMICAL FILM FOR EVAPORATION RETARDATION UNDER  
FIELD CONDITIONS

Leaders: William J. Waldrip, John A. McLemore and P. T. Marion, Texas  
Experimental Ranch, Substation No. 7, Spur, Texas; and R. J.  
Hildreth, Agricultural Experiment Station

Nature of Research: Twin farm ponds equipped with stilling wells were constructed for study of use of long chain alcohols as monomolecular film for reduction of evaporation. Material is supplied to one of the twins while the other serves as a check. Complete weather instrumentation as well as instrumentation for determining water loss by the energy-budget method is available. Daily differences in water stage are the principal means of determining the effectiveness of the film. The material used is a 50-50 mixture of hexa- and octadecanol--fatty alcohols which are odorless, tasteless and non-toxic to plants and animals.

Progress: High wind movement is the most serious limiting factor in maintaining a constant film on the water surface. On ponds the film has a tendency to collect and be lost on the downwind bank.

A solid emulsion has been far inferior to liquid applications in tests to date. Applications of the material with isopropanol from five gallon cans equipped with capillary drippers have given savings up to 25 per cent. However, the lowest material cost has been \$3.80 per thousand gallons saved. Further work is necessary to reduce chemical losses and to improve dispersal systems.



Title: GRAZING MANAGEMENT AND NUTRITION FOR COW-CALF OPERATIONS IN THE ROLLING PLAINS (1959 - page 124)

Leaders: William J. Waldrip and P. T. Marion, Texas Experimental Ranch, Substation No. 7, Spur, Texas; and R. J. Hildreth, Agricultural Experiment Station

Progress: After only one year of operation, definite trends have not been established. However, calf crop, calf weights, and cow weights were greatest on deferred-rotation pastures. No difference was discernible from 0,  $1\frac{1}{2}$ , and 3 pounds of cottonseed cake per day as winter supplement except that loss in weight of mother cows was reduced by supplemental feeding.

Bobwhite quail population decreased 25.5 per cent during winter over the ranch as a whole but increased 37 per cent under continuous light grazing and 128 per cent under deferred-rotation grazing.

Title: COLLECTION AND PRELIMINARY OBSERVATION OF NATIVE RANGE GRASSES (S-9) (1959 - page 120)

Leaders: Eli Whiteley, Department of Agronomy, and W. G. McCully, Department of Range and Forestry

Progress: Additional collections of contrasting types of Panicum virgatum and Elymus canadensis have been made on an opportunity basis. A smaller number of samples of seeds of other perennial range grasses have been collected also.

A number of collections assembled previously will be grown and characterized during the current season.

Grower reaction to the Premier sideoats released in 1960 was excellent. They were particularly impressed with the seedling vigor, the high seed yield and the good seed retention by this line of sideoats as specified in the variety description.

## UTAH

**Title:** THE EFFECT OF GRAZING UPON VEGETATION AND SOIL ON MOUNTAIN SLOPES

**Leaders:** C. Wayne Cook, D. L. Goodwin and L. A. Stoddart, Department of Range Management. Cooperating with the U. S. Forest Service

**Objectives:** 1. To determine the effect that grazing has upon vegetation, soil, and soil-water relationships as influenced by slope, soil type, vegetation, and exposure.

2. To determine if brush control and fertilization will encourage livestock to use steep slopes and to what extent such treatment affects production and watershed conditions.

**Progress:** It was found that livestock could be encouraged to move out of valley bottoms onto slopes by the use of brush control and fertilization.

Fertilization increased production of forage and palatability of forage. Study areas were located, experimental exclosures fenced, and vegetation cover maps completed.

**Future Plans:** To fertilize local areas on slopes not normally used to determine if animals will move onto them from other areas of concentration. Fence areas perpendicular to drainage to see if animals can be forced out of bottoms onto slopes and by rotating areas, determine if more effective use can be made of summer ranges. Complete initial grazing of experimental exclosures and determine immediate effects of such grazing upon vegetation and soil.

**Title:** LIVESTOCK RESPONSES FROM SEEDED AND UNSEEDED FOOTHILL RANGES AND MAINTAINING GRASS STANDS THROUGH THE USE OF FERTILIZERS AND HERBICIDES (1959 - page 125)

**Leaders:** C. Wayne Cook and L. A. Stoddart, Department of Range Management. Cooperating with the Bureau of Land Management

**Progress:** Tall and intermediate wheatgrass produced better calf gains than either crested or pubescent wheatgrass or the native sagebrush-grass range, but crested wheatgrass produced the highest cow gains.

Even though the precipitation during 1959 and 1960 was below normal, the control of sagebrush by herbicides increased grass yields as much as 250 pounds per acre.

The control of annual weeds with herbicides is generally beneficial for seedling establishment. In some years the benefits are more pronounced for seedlings during their first growing season, but in other years the benefits are greater during the second year of growth.



The application of nitrogen fertilizer at the rate of 40 pounds per acre on seeded foothill range increased production the first year as much as 500 pounds and an additional carryover of 200 pounds the following year.

Future Plans: Cattle and sheep grazing trials will be carried out as during the previous year. The control of both rabbitbrush and sagebrush that have invaded seeded ranges will be studied to determine the extent of competition of these two species with the seeded grasses. Halogeton will be controlled on newly seeded areas to determine the competitive effect of this plant with seedlings during the first two years of growth.

Fertilizers will again be applied to new seedings and established stands of seeded grasses on foothill range to determine the benefits of fertilization on dry range lands.

**Title:** INVESTIGATIONS OF THE MARKETS, VALUE, DISTRIBUTION AND MANAGEMENT OF UTAH JUNIPER IN THE STATE OF UTAH

**Leaders:** J. Whitney Floyd and T. W. Daniel, Department of Forest Management. Cooperating with the U. S. Forest Service and Bureau of Land Management

Objectives: To determine (1) commercial value of Utah Juniper posts in Utah and inter-state commerce, (2) distribution, age classes, and volume of Juniper stands in Utah, and (3) silvical and silvicultural factors affecting the management of Juniper stands.

Progress: Report by John Quinn on the amount of decay in the juniper stand in the Snowville area was completed. Decay was found in trees as small as six inches in diameter and became increasingly prevalent with increase in diameter until at 12 inches almost all trees had decayed heartwood.

Future Plans: Study of the Christmas tree and fence post production on selected areas in Utah.

**Title:** THE INFLUENCE OF SMALL MAMMALS UPON RANGE FORAGE PRODUCTION AND AVAILABILITY (1959 - page 125)

**Leaders:** DuWayne L. Goodwin and L. A. Stoddart, Department of Range Management, and J. B. Low, Department of Wildlife Management

Progress: Studies of methods of detecting utilization of native vegetation and of determining quantity of forage taken were completed. These results have been included in a Ph. D. dissertation which is near completion. Average daily use of three species (Atriplex confertifolia, A. nuttallii mittallii, and Eurotia lanata) as determined in barn feeding trials was 5.24, 49.24, and 42.83 gr. (O D weight), respectively. In terms of rabbit to ewe equivalents this becomes 15.38 : 1. Trials in field pens yielded variable results depending upon composition of vegetation and number of days in pen. Rabbit

equivalent values based on daily range forage requirements of ewes on winter range for a mixed Atriplex nuttallii - Eurotia lanata type for one day were 7.02 : 1, 5.56 : 1, and 6.57 : 1 for one, two and three day trials, respectively. Average over-all trial values for rabbit-cow equivalents, assuming that a 1000-pound cow requires 20 pounds of forage per day, were 41.7 : 1, 130.1 : 1, and 73.3 : 1 for one, two and three day trials.

Pellet transects and utilization grids proved to be quite sensitive means of detecting jackrabbit activity.

Future Plans: Complete summarization and publication of data; concentrate on studies of jackrabbits in pastures and initiate studies of kangaroo rat.

Title: PASTURE STUDIES IN UTAH COUNTY

Leaders: Lorin E. Harris, Department of Animal Husbandry, Keith R. Allred and Milo L. Dew, Department of Agronomy

- Objectives:
1. To study pasture yield as measured by beef cattle growth.
  2. To study the influence of Reed Canary Grass on pasture yield.
  3. To study fertilization with nitrogen, phosphate and barnyard manure in various combinations on pasture yield and legume-grass ratios.
  4. To sample pasture as a measure of fluoride deposition in an area near an industrial plant.

Progress: In the previous two years' grazing, it was found that bloat was a considerable hazard when the pastures were grazed. Because of this fact, it was decided to plow up the pastures and reseed them to three pasture mixtures which may not produce so much bloat. Therefore, during the past season the electrical fences were all removed and the pastures were all plowed.

The suggested pasture mixtures which will be seeded in the pastures during the spring of 1961 are as follows: Mixture No. 1 - brome grass 3 lb/acre, orchardgrass 3 lb/acre, tall oatgrass 4 lb/acre, red clover 2 lb/acre, ladino clover 1 lb/acre, alfalfa 1 lb/acre; Mixture No. 2 - brome grass 4 lb/acre, orchardgrass 3 lb/acre, birdsfoot trefoil 7 lb/acre; and Mixture No. 3 - brome grass 4 lb/acre, orchardgrass 3 lb/acre, intermediate wheatgrass 7 lb/acre, and alfalfa 1 lb/acre.



**Title:** NUTRITIONAL DEFICIENCIES IN RANGE FORAGE AND THE SUPPLEMENTARY FEEDING OF RANGE LIVESTOCK (W-34)

**Leaders:** L. E. Harris, J. E. Butcher and D. O. Williamson, Department of Animal Husbandry, and C. W. Cook, Department of Range Management

**Objectives:** 1. To determine the botanical and chemical composition of the diet of range livestock.

2. To evaluate micromethods for estimating the nutritive content of range forage and similar roughages by livestock.

3. To determine the protein and energy requirements of pregnant range ewes.

**Progress:** Ranges in good condition produced 130 pounds per acre more forage than ranges in poor condition and were higher in all chemical constituents in the diet except ether extract and ash, which were higher on poor ranges. Diets under light use were higher in ether extract and protein, and diets under heavier use were higher in ash, cellulose, and gross energy. Daily intake was reduced under heavier utilization. Lighter utilization furnished more digestible protein and metabolizable energy. Supplemented animals consumed 0.43 of a pound of range forage less per day than unsupplemented animals. Supplements increased the digestibility of protein in the diet but depressed all other constituents. Twenty-seven rumen fistulated lambs were used to study the influence of three levels of nitrogen and three levels of phosphorus supplements on the composition of the ruminal ingesta of sheep grazing desert range forage. Neither phosphorus nor nitrogen influenced the concentration or molar percentage of the other volatile fatty acids. Increasing the amount of phosphorus elevated the total rumen phosphorus concentration. Nitrogen or phosphorus did not affect the rate of cellulose digestion or gross energy.

**Future Plans:** To determine the daily consumption of wet and dry ewes and the effect of range condition on intake and digestibility of summer range forage. Fistulated lambs will be fed a controlled ration which will be supplemented with phosphorus and protein. This work will serve to check the results which were obtained in the field.

**Title:** GRAZING AND LIVESTOCK MANAGEMENT OF RESEEDED ABANDONED FARM AND DEPLETED RANGE LANDS

**Leaders:** Lorin E. Harris and Neil C. Frischknecht, Department of Animal Husbandry

**Objectives:** 1. To determine how grazing crested wheatgrass during different seasons affects the grass, invasion of brush, and grazing capacity.

2. To determine if a protein supplement fed with crested wheatgrass during the summer and fall improved the utilization of the grass and increases the carrying capacity of the pastures.

3. To determine how to control brush in pastures which have been seeded to crested wheatgrass and grazed for a number of years.

4. To determine the grazing practices conducive to the largest livestock production consistent with requirements for maintaining the productivity of areas reseeded to crested wheatgrass and for protecting the land.

Progress: Thirty pastures were divided into three blocks of 10 pastures each. Within each block the following grazing treatments were allotted: all spring, early spring and fall without supplement, early spring and fall with supplement, late spring, summer without supplement, summer with supplement, early fall without supplement, early fall with supplement, late fall without supplement, and late fall with supplement. All pastures were grazed at an intensity of approximately 60 per cent to obtain a base line for future experiments.

Future Plans: The pastures will be grazed similarly next year.

Title: DEVELOPMENT, MORPHOLOGY AND MINERALOGY OF RANGE AND FOREST SOILS

Leader: Raymond W. Miller, Department of Agronomy

Objectives: 1. To make detailed chemical, physical, and mineralogical studies of genetic horizons of some representative profiles.

2. To study interrelationships of climate, parent material, and soil profile development.

3. To determine the proportions and types of clays present.

4. To study conditions and effects of vegetative succession as related to changes in the soil profile.

Progress: A buried site in Cache Valley was sampled for additional study that will relate to the history of Lake Bonneville.

A study of interrelations of soil physical properties, freezing, compaction and permeabilities was completed. Compaction effects on soil are decreased by increased texture coarseness and increased soil density. The smallest decrease in permeability with compaction occurred in platy and granular structure. Freezing and thawing usually decrease soil permeability and weaken strong aggregates. Fine-textured soils are most affected. Drainage of excess water decreases the effect of freezing. Freezing increases a soil's compressibility. Conversely, a compacted soil's permeability is improved by freezing-thawing; the effect, again, is greatest in finer textured soil. Platy soils exhibit the least change. Greatest soil damage occurs from compaction of low bulk density soil after freezing of the wet soil and subsequent thawing.



Future Plans: Complete previous work for publication. Initiate a detailed study on the movement of soil mineral components and its relation to the soil profile variations, the soil mineralogy, solution composition and plant composition.

Title: RANGE AND PASTURE DEVELOPMENT AND USE (1959 - page 126)

Leaders: Phil R. Ogden, Department of Range Management, Darrell Matthews, Department of Animal Husbandry, and L. A. Stoddart, Department of Range Management. Cooperating with Bureau of Land Management, Soil Conservation Service, and Intermountain Forest and Range Experiment Station

Progress: A major emphasis of the year was to outline and do some preliminary work on an intermediate wheatgrass physiology study. Plots were established and an initial study on use of food reserves by plants when etiolated and clipped was undertaken. The chemical analyses of the samples collected during the summer and fall of 1960 are not yet completed.

An ecology study was initiated on sagebrush-grass on the winter range and an enclosure was constructed for this study.

Ninety chains of rabbit fencing were constructed during the summer of 1960 to protect a seeded area severely damaged by rabbits. Costs of fencing and effectiveness of the fence were checked. Both poultry and rabbit net wire fencing, when new construction, and 2" x 2" x 24" chicken net, when placed along the bottom of an established fence with the bottom covered with soil, were effective in keeping rabbits off the seeded area.

Future Plans: Continue intermediate physiology study. Continue winter range sagebrush-grass ecology study. Complete a temperature and evaporation study on furrowed and level areas. Prepare an initial report on aspen studies completed on the summer range.

Title: ECONOMICS OF CONTROL OF UNDESIRABLE PLANTS ON UTAH RANGE LANDS (W-16)

Leaders: N. K. Roberts, Department of Agricultural Economics, and Eugene Cronin, Department of Botany and Plant Pathology and Agricultural Research Service. Cooperating with U. S. Forest Service

Objectives: 1. To study costs and methods of controlling undesirable range plants and the effects on range forage production and utilization in Utah.

2. To study the effects of undesirable plant control practices on resource organization and net returns to ranchers in Utah.

3. To study economic and physical conditions and institutional factors which affect Utah ranges as a basis for future public policy decisions regarding range use.

Progress: Work concentrated on the economics of controlling tall larkspur (Delphinium barbeyi). The Manti Canyon Cattlemen's Association allotment in the Manti-LaSal National Forest was selected for a case study. The Agricultural Research Service and the Forest Service accepted an invitation to participate formally in the research.

Between 1956 and 1959 members of the Association lost an average of \$14,125 per year to tall larkspur poisoning. Death losses ranged from 6.2 per cent in 1959 to 12.8 per cent in 1958. In 1958 one rancher lost 20.7 per cent of his animals; another rancher lost only 3.4 per cent.

The total area of tall larkspur on the allotment in 1960 was 343.5 acres. Mr. Cronin, ARS, worked on chemical kill of tall larkspur, testing several chemicals at varying rates in two time periods. Results will not be known until June or July 1961.

Costs of range improvements were assembled from BLM and Forest Service project records.

Future Plans: A small plot experiment will be conducted by Mr. Cronin on control of tall larkspur with varying rates and time of application for promising chemicals. Economic data on control will be developed from simulated treatments on measured acres on selected sites.

Utah ranches will be stratified by type, and resource use and ranching costs determined by stratum.

Title: ECONOMICS OF ACQUIRING AND MANAGING STATE LANDS FOR SURFACE USES

Leaders: N. K. Roberts and E. B. Wennergren, Department of Agricultural Economics. Cooperating with Bureau of Land Management

Objectives: 1. To forecast the economic potential to the state of federal lands available for state acquisition.

2. To study the economics of management alternatives for selected sites and uses.

Progress: Work concentrated on lands available to the state for acquisition, management and trade which are within Bureau of Land Management grazing districts. In 1959 the Land Board received about \$110,000 from grazing leases on about 2.4 million acres. Approximately 350,000 acres of state lands were unleased in 1959. State lands were stratified by BLM district and subunit. Acreages, fees, obligated and suggested acres per AUM were estimated for each BLM subunit. No significant correlation was found between 1959 state fees and suggested carrying capacity. Formal fee setting systems were suggested to the Board as a means of increasing returns from grazing. Land trading ratios were established with suggested acres per AUM as a basis for estimating relative quality of lands. Blocking state land within BLM districts was evaluated economically. Other research was initiated on the economics of improving



state land blocks, land sales-investment programs, lieu land selections, Christmas trees on state lands, land use projections, and effect of changes in Land Board policies on local, state, and ranch economics.

Future Plans: Research will continue on the economics of blocking state lands, improving state land blocks, sales-investment programs, lieu land selections, Christmas trees on state land, surface use changes over time, and the effect of changes in State Land Board policies on local and ranch economies.

Title: CAUSES OF CHANGES IN DISTRIBUTION AND FORAGE PRODUCTION OF RANGE PLANT COMMUNITIES OF THE SHADSCALE ZONE (W-25)

Leaders: L. A. Stoddart, C. W. Cook and D. L. Goodwin, Department of Range Management. Cooperating with Bureau of Reclamation

Objectives: 1. To determine and describe the characteristics of the vegetation of the shadscale zone in terms of composition, density, canopy coverage, and phenology.

2. To determine the nature of change in relationship as influenced by grazing between shadscale, saltsage, winterfat and big sagebrush communities.

3. To determine the causes of changes in the relationships of communities of the zone.

4. To determine seed production, seed viability, germination, and seedling development of the major forage species of the shadscale zone.

Progress: Vegetation transects established in 1958 were measured. Relatively little change in composition was discovered except for a small decrease in winterfat in areas where this species occurred in mixed stands. Field germination and seedling survival studies on gypsiferous soils were initiated. Species used were Elymus salinus, Oryzopsis hymenoides, Agropyron elongatum, and Sphaeralcea grossulariaefolia. Fall germination was variable amounting to about 25 per cent for A. elongatum to less than one per cent for S. grossulariaefolia.

Desert plants harvested during the late spring produced more herbage than plants harvested during the winter or during early spring, but the vigor of the plants harvested in late spring was lower than plants harvested during winter or early spring. Moderate intensity of harvesting (60 per cent) produced more herbage than either light (30 per cent) or heavy (90 per cent) at the end of the second year of treatment. Vigor was reduced in direct proportion to intensity of harvesting.

Future Plans: Seed production, seed germination, and seedling establishment of three of the major species will be determined. Reproductive capacity studies will be initiated. Spring plantings on gypsiferous soils will be made. First-year observations of the response of plant communities to reduction in density of one species will be completed.

#### WASHINGTON

**Title:** COMPETITIVE RELATIONSHIPS BETWEEN CHEATGRASS (BROMUS TECTORUM L.), BLUEBUNCH WHEATGRASS (AGROPYRON SPICATUM (PURSH.) SCRIB.) AND OTHER IMPORTANT PERENNIAL GRASSES OF THE COLUMBIA BASIN (1959 - page 128)

**Leader:** Grant A. Harris, Department of Forestry and Range Management

Progress: Preliminary tests show that medusahead seedling roots initially grow much faster than those of cheatgrass and bluebunch wheatgrass. This may partly account for the ability of medusahead to displace cheatgrass on many sites. The first leaf of wheatgrass seedlings appeared shortly after germination and sometimes before initial root development. In contrast, the primary root of the two annual species elongated rapidly, reaching two to four cm. before the first leaf broke through the lemma and palea sheath.

Seed of medusahead germinated 81% in 24 hours, 98% in 48 hours and 100% in 72 hours. Under essentially identical laboratory conditions, wheatgrass seed germination reached a peak of 43% in 72 hours and cheatgrass seeds a peak of 48% in 48 hours. Agar-agar was found to be superior to filter paper as a germination medium.

The two annual grasses were found to be more responsive to increased levels of nitrogen than was bluebunch wheatgrass.

**Title:** IMPROVED MID-SUMMER RANGE FORAGE FOR BEEF CATTLE IN EASTERN WASHINGTON (1959 - page 130)

**Leader:** Grant A. Harris, Department of Forestry and Range Management

Progress: Six units, each twenty acres in size, have been seeded in two replications to three species or combinations of species suitable for mid-summer grazing use. These are (1) Whitmar (Agropyron inerme), (2) intermediate wheatgrass (Agropyron intermedium), and (3) intermediate wheatgrass plus alfalfa.

These will be grazed and animal gains determined during late June and July. Forage yield studies, utilization surveys and chemical analyses of forage samples will be made.



Stands of the forage species are established, and grazing trials will start in 1962.

Title: RELATIVE VALUE OF SELECTED RANGE GRASSES FOR SPRING FORAGE  
(1959 - page 129)

Leader: Grant A. Harris, Department of Forestry and Range Management

Progress: Grazing trials have been conducted five different years on four 5.84-acre pastures containing selected grass species in order to measure relative spring forage value.

Pounds of gain have been compared and intermediate wheatgrass (Agropyron intermedium) was found to produce more gain than any of the other three species of grasses: crested wheatgrass (Agropyron desertorum), smooth brome (Bromus inermis), and pubescent wheatgrass (Agropyron trichophorum).

No grazing trials were conducted in 1960 in order that the pastures could be given a rest from May 1 throughout the remainder of the growing season. In 1961, grazing trials will be conducted at the earliest possible date in the spring. This period will be two weeks to six weeks earlier than the previous trials which ran from latter May into early June.

Title: FORAGE CROP AND RANGE STUDIES IN THE DRY LAND AREAS OF EASTERN WASHINGTON

Leader: J. K. Patterson, Department of Agronomy

Objectives: 1. To survey actual and potential yields of various range sites of different range conditions.

2. To explore the economic possibilities of nitrogen application to native and re-seeded range lands.

3. To determine adaptations and yields of grasses and legumes on range lands.

Progress: Topar pubescent wheatgrass was dropped from the recommended list of varieties and Hard fescue was added: Two alfalfas, A 124 and A 169, show promise in our dry land areas. Siberian wheatgrass has performed unsatisfactorily.

A tetrazolium technique for testing vigor was developed for wheat. Application of this test to forage grass and legume seeds will require further research.

Title: SOIL CLASSIFICATION AND SURVEY (1959 - page 131)

Leaders: Warren A. Starr and Raymond A. Gilkeson, Soil Classification and Survey

Progress: In 1959-60 progress of classification and survey of soils was in two areas:

a. National forest and Weyerhaeuser Co. forest lands. Some of this land is intermingled open grazing land or grazed forest.

b. Survey of all University Experiment Stations in the State of Washington. This will facilitate transfer of research data to other similar lands.

Future Plans: To divert from routine survey of administrative or political land units, and concentrate upon classification and survey of soils on climatic, transect, or physiographic area basis, to:

a. Investigate soils in remote areas of the State, where no work has yet been done.

b. Investigate soils where desirable to bring out interpretive relationships to management programs or other associated research projects.

#### WYOMING

Title: A STUDY OF RANGE CONDITION CLASSES ON THE SHOSHONI NATIONAL FOREST OF WYOMING

Leader: A. A. Beetle, Department of Range Management

Objectives: To determine range condition classes within the forest boundaries for all the major range types.

Progress: Work was begun in 1960 and will be greatly increased in 1961.

Title: GRAZING STUDIES ON SEEDED PASTURES AND NATIVE RANGE (1959 - page 135)

Leaders: Robert Lang, Department of Range Management. Cooperating with Frank Rauzi, Agricultural Research Service

Progress: A combination of seeded annual pastures (winter wheat, oats and corn) was grazed for a total of 389.4 sheep days per acre. A total of 107 pounds of lamb gain per acre was obtained. Cows and calves were grazed on the combination of seeded pastures and native range at the Gillette Substation. The grazing period was very short due to drought conditions in 1960. A pasture



of oats at the Sheridan Substation was grazed for 97.3 ewe days and 100.5 lamb days per acre. A sudan grass pasture at this station was grazed 191 ewe days per acre. Four 8-acre pastures were seeded in the spring of 1960 on the range and forage farm west of Laramie. Two of these pastures were seeded with a grass mixture alone and two with the same grass mixture and alfalfa. They will be grazed by yearling steers in the summer of 1961.

Title: MECHANICAL TREATMENT AND SEEDING OF RANGELANDS (1959 - page 134)

Leaders: Robert L. Lang, Department of Range Management, and Clarence Becker, Department of Agricultural Engineering. Cooperating with Frank Rauzi, Agricultural Research Service

Progress: Native pastures treated with the Wyoming Range Seeder and the range pitter in the spring of 1955 at the Archer Substation yielded 54 and 41 sheep days of grazing per acre, respectively. For comparison, 32 days of grazing per acre were obtained from the moderately grazed non-treated pastures. In terms of pounds of lamb gain per acre, the yield was 37, 44, and 41 pounds, respectively, for the above three treatments.

It was very dry in 1960 and only 68 days of grazing were obtained from the native pastures at Archer.

Pitted plots in the Gros Ventre area yielded 378 pounds of perennial grass per acre, compared to 192 from non-treated check plot. The most productive seeded species in 1960 were Amur intermediate wheatgrass, Primar slender wheatgrass, Nordan desert wheatgrass, and Russian wildrye. Many young sagebrush plants were noted in all seeded and pitted plots. Small plot seedlings in other areas were largely failures due to general drought conditions. The study of methods of converting plowable native range to seeded pastures was concluded and data partially summarized.

Title: COMPARISON OF ROTATION GRAZING AT TWO INTENSITIES WITH SEASONLONG SUMMER GRAZING IN TERMS OF VEGETATION AND ANIMAL GAINS (1959 - page 136)

Leaders: Dixie R. Smith, Department of Range Management. Cooperating with U. S. Forest Service, Bighorn Permittees Association, and Wyoming Board of Natural Resources

Progress: Experimental pastures were grazed according to plan during the summer of 1960. Three-unit rotation systems have resulted in more favorable steer gains as compared with seasonlong grazing. Conclusions cannot be made at this time due to inherent variation in productivity among pastures.

Rotation grazing has not resulted in more uniform grazing - a feature commonly associated with the system.

Title: LIVESTOCK DISTRIBUTION STUDIES (1959 - page 136)

Leader: Dixie R. Smith, Department of Range Management

Progress: The effect of nitrogen fertilization upon forage utilization, production, and chemical composition was studied over a 5-year period.

Nitrogen fertilization of native range resulted in a significant increase in production of grasses only in 1960 when trials were located on Burgess fine gravelly loam. Under these conditions, the relationship between rate-of-application and production of grasses was non-linear. Maximum yields were obtained with 50 pounds of nitrogen per acre. Additional increments led to decreased yields. With optimum application rate, the increased yield was estimated at about 150 pounds of oven-dry forage per acre. Although statistically significant, the increase did not approach economic feasibility.

Maximum response to fertilization (in terms of grass production) was obtained when combined with control of broad-leafed plants. But again, the expense did not appear justified.

There was some indication that heavy applications of nitrogen to soil of the Owen Creek silt loam series resulted in lower yield of forbs.

Crude protein content of Idaho fescue was increased by nitrogen fertilization. The maximum rate of increase was obtained with applications of 25 pounds of nitrogen per acre. With higher levels, crude protein content averaged about five per cent greater than plants growing on unfertilized range.

Forage palatability was increased by fertilization, and this characteristic was employed to increase the amount of cattle use on areas normally subject to very light grazing. It appeared that maximum success may be achieved by complete coverage of problem areas with 25 pounds of nitrogen per acre. Soils of granitic origin may be expected to give maximum response.

Title: THE IMPROVEMENT AND USE OF RANGELANDS THAT ARE THREATENED BY HALOGETON GLOMERATUS (1959 - page 134)

Leaders: L. C. Vosler and Dixie R. Smith, Department of Range Management. Cooperating with the Bureau of Land Management

Progress: Native saltsage range near Greybull has been grazed at different intensities since 1956. Data relative to sheep weights and vegetation cover, production and utilization, were collected during the current year.

Experimental pastures were established in 1960 on native saltsage range. One pasture was treated with waterspreaders which were seeded to kochia, tall wheatgrass and crested wheatgrass; the other pasture of native range was used for a comparison of steer gains and vegetation response.

Additional stations were established for a long-term study of vegetative, biotic, climatic, and edaphic interrelationships on arid ranges.



CROPS PROTECTION RESEARCH BRANCH

CROPS RESEARCH DIVISION

AGRICULTURAL RESEARCH SERVICE

Title: UNDESIRABLE RANGE PLANTS AND THEIR CONTROL (1959 - page 137)

Progress in research is reported briefly and does not include all research underway. Research that was mentioned in the 1959 Compilation is omitted from this report. In addition, only enough information is given on a few of the studies underway to indicate the nature and most important findings of an investigation. Those interested are invited to write to the individual investigator for more details. The name of the scientist concerned with each study is indicated. The names of active cooperators also are shown.

Research on grazing land weeds and their control is conducted by personnel in Weed Investigations - Grazing Lands, Crops Protection Research Branch. These personnel and their addresses are listed at the end of this report. All of our research is in cooperation with other Federal and State agencies and chemical companies.

Physiological Investigations. In absorption, translocation and degradation studies of radioactive 2,4-D by ironweed, Vernonia baldwini, in Nebraska, the field-treated plants contained two per cent of the applied activity as absorbed 2,4-D, 21 days after treatment. Twenty-one days after treatment of seedlings in the greenhouse, 1.1 per cent of the applied 2,4-D-C<sup>14</sup> was recovered. While on slow-growing ironweed transplants in the greenhouse, over 30 per cent of the applied 2,4-D-C<sup>14</sup> was recovered 21 days after treatment. Approximately, three per cent was recovered as absorbed 2,4-D and 27.5 per cent as residue on the leaf. Autoradiography studies indicated that considerable amounts of activity remained in ironweed seedlings and transplants that could not be accounted for by intact 2,4-D-C<sup>14</sup> (Linscott and McCarty). In Texas, over 80 per cent of the 2,4,5-T-1-C<sup>14</sup> applied to silver bluestem, Andropogon saccharoides, and over 84 per cent of that applied to sideoats grama, Bouteloua curtipendula, had disappeared ten days after treatment. Sixty days after treatment, 93 and 98 per cent of the radioactivity had disappeared from the silver bluestem and sideoats grama plants, respectively (Morton).

The assumed translocation of C<sup>14</sup> labeled 2,4,5-T was greatly reduced in blackjack oak after 12 hours in Oklahoma. This reduction may have been because of the occurrence of darkness between the 12 and 24 hour collections. The leaves collected 24 hours after treatment appear to indicate that the labeled herbicide was not translocated during periods of darkness. However, absorption appears to continue at a reduced rate during the night. The difference in assumed translocation between the 24 hour and 36 hour collections appears to indicate that translocation is resumed at a much reduced rate during the second day (Elwell, Dalrymple, Basler).



## Research on the Control of Specific Weeds.

(1) Downy brome grass. Downy brome grass, Bromus tectorum, responded more to increasing levels of nitrogen than did crested wheatgrass in controlled greenhouse experiments in Nevada. Crested wheatgrass responded only to high rates of nitrogen. Downy brome grass responded to intermediate as well as high rates of nitrogen. In an established stand of intermediate wheatgrass, downy brome grass was more able to utilize high nitrogen than the wheatgrass and provided severe competition to this species. Under grazing and high nitrogen, the wheatgrass was reduced to a low percent of stand (1.7%) and percent ground cover (0.5%) (Evans, Eckert, Kinsinger).

(2) Giant foxtail. Giant foxtail (Setaria faberii Herrm.) seed must be pre-conditioned at 4° C. under moist conditions for two weeks to break primary dormancy. Greater growth of Giant foxtail occurs at higher temperatures and longer photoperiods. Time of flowering is not dependent upon the length of photoperiod, but flower initiation appears to be favored by shorter photoperiods. Seed production per panicle is related to photoperiod - the longer the photoperiod, the greater the seed production. Clipping to control Giant foxtail does not generally prevent seed production but only alters the time of flowering and the length of panicle (Schreiber).

(3) Timber-line milk vetch. Timber-line milk vetch (Astragalus miser var. decumbens) is quite toxic to cattle and much less toxic to sheep and other animals. Silvex at 2 and 4 lb/A in the first year's study in Utah removed 99 to 100 per cent of this poisonous weed and resulted in an apparent increased growth of the grass species in the treated plots (Cronin, Williams).

(4) Jumping cholla cactus. Annual growth rate of jumping cholla cactus, Opuntia fulgida, over a 12-year period in Arizona averaged 0.67 inches. Height of small plants averages three inches growth per year, decreasing gradually with age. Height growth of most plants stops at about 48 inches (Tschirley).

Research on the Control of Brush. A 40-acre field was sprayed with 2,4-D to kill big sagebrush in Oregon in 1952 and has been grazed by yearling Herefords in July or August each year. Hbage production continues at a level that is about three times as much as before spraying. In the eight years since spraying at a cost of about \$2.50/A, there has been a total hbage gain of about 4,000 lb/A. Sagebrush reinvasion continues very slowly.

The influence of understory grasses upon sagebrush invasion was studied. Among overstory grasses, crested wheatgrass was strongest in establishment vigor and restricted brush invasion more than other species. Understory grasses restricted brush invasion in comparison to unseeded plots, but didn't help much as companion understory species in the mixed seedings. One should obtain thorough brush control before seeding, then plant a single overstory species in a way that gives maximum assurance of good stands. If thick stands of sagebrush become established in the first year or two after seeding, they can be eliminated easily with 2,4-D (Hyder, Sneva).



Good control of buckbrush (Symphoricarpos occidentalis) in Nebraska resulted from spraying with 2,4-D and a mixture of 2,4-D and 2,4,5-T at rates of 1 and 2 lb/A on May 12 and 19. They were less effective when sprayed on June 6. The plots that were mowed gave an initially clean appearance but by late summer buckbrush shoots were as numerous as in the original stand (McCarty).

Basal stem sprays of 2,4,5-T ester were more effective on blackjack oak in Louisiana when applied to the root collar and sprouting zone than when applied higher on the stems or on the soil (Peevy).

Alligator juniper, Juniperus deppeana, in Arizona responded more rapidly to basal soil applications of pelleted fenuron than Utah or one-seed juniper. Bioassay tests showed fenuron was still active after three years in a clay soil. Fenuron was detected in a sandy loam soil from the same area after 2½ years. It is suspected that soil temperatures influence effectiveness of fenuron. Pelleted fenuron kept in an open container in the dark at 140° F. lost effectiveness. After 24 hours 32 per cent effectivity was lost, after 48 hours 54 per cent, after 168 hours 80 per cent (Johnsen).

Fenac applied as a foliage spray and granulated 2,3,6-TBA in basal soil applications showed promise for controlling junipers.

Nonemulsifiable monochloroacetic acid applied as a wetting spray at eight pounds per hundred gallons was an effective desiccant of one-seed juniper under both wet and dry conditions during the summer. Chemical desiccation may help in the use of broadcast fires to control these trees (Johnsen).

High rates (8 lb/A) of 2,3,6-TBA applied in two successive years have severely damaged sprouts following burning shrub live oak. This treatment caused a high degree of topkill and suppression of resprouting. Pelleted fenuron at 8 lb/A or higher also looks promising for the control of oak although the plants have not been completely killed two years after treatment. Fuel moisture of shrub live oak leaves may be reduced from 100 per cent in the checks to the 15-20 percent level (dry weight basis) eight weeks after treatment with 2 lb/A of 2,4-D, 2,4,5-T or silvex. This may allow burning of shrub live oak during the less hazardous seasons (Lillie).

One-quarter pound per acre of silvex killed shinnery oak nearly as well as one pound per acre in Oklahoma. Small differences due to rate of application were obtained when shinnery was sprayed for two successive years, 1958 and 1959. Percentages killed were 82, 86, and 91 for rates of .25, .51, and 1 lb/A, respectively, in 1960 (McIlvain, Armstrong).

The low-volatile esters of 2,4,5-T and silvex are effective for general brush control for native grass improvement in Oklahoma. These materials have a wide range of effectiveness on woody species, and their action in foliar sprays apparently is not materially influenced by soil variations. Oak and hickory defoliation and apparent kill were about equal from comparable aerial applications of 2,4,5-T as the butoxy ethanol, propylene glycol butyl ether, and isooctyl ester formulations (Elwell).



None of the presently available phenoxy herbicides or economical rates of fenuron and 2,3,6-TBA in aerial applications have satisfactorily controlled elms, hawthorn, small flowered dogwood, ash, and huckleberry (Elwell).

Persimmon, Diospyros virginiana, has been effectively controlled with 0.5 pound of 2,4,5-T ester per acre in foliar water spray in three applications. By spacing each application one or two years apart, the regrowth and sprouts have been killed. Persimmon has not been satisfactorily killed with 2,4,5-T ester applied as basal-bark treatments. Fenuron, 25% pellets, at 15 pounds of active chemical per acre had little or no effect on persimmon (Elwell).

Hawthorn, Cratoegus sp., was effectively controlled with 20 pounds of low-volatile ester of 2,4,5-T per hundred gallons of diesel oil applied in basal-bark and injector treatments (Elwell).

Research on the Control of Grassland Weeds. Feeding trials in Utah with seleniferous halogeton, Atriplex canescens, and Astragalus preussii were completed with sheep. It was found that combining selenium and oxalates resulted in a toxic effect that was neither additive nor synergistic. Fatalities occurred at combinations which, if fed separately, would have failed to produce symptoms of intoxication (Williams, Binns).

After three years' evaluation, 4 lb/A of IPC applied in early spring appeared most satisfactory of several herbicides tested for suppression of downy brome-grass in intermediate wheatgrass in a semi-arid area of eastern Washington (Robocker, Kerr).

Amitrole, amitrole-T, maleic hydrazide, and to a limited extent, dalapon showed promise as herbicides on medusahead in California. These herbicides were effective in inhibiting seed formation, seed germination, or seedling development depending upon time of application (boot to soft dough stage) and kind of herbicide. Seed damage to soft chess occurred when herbicides were applied early. Late application had no effect on soft chess (Evans, Kay, McKell).

Chlorinated phenoxyalkylcarboxylic acid formulations are effective for control of camelthorn only if repeated within seasons over a number of seasons in Washington. All camelthorn plants in plots treated with 16 lb/A of 2,3,6-TBA were completely killed, and no reinfestation of plots from border areas has occurred over a three-year period (Kerr, Robocker).

In Nebraska 1 lb/A applications of 2,4-D to ironweed resulted in decreased bud and stem numbers, increased bud and root proliferation, increased bud dormancy, abnormal root formation, necrosis and lesions of roots and increased decay of roots and rhizomes due to bacterial and fungal action. The degree of abnormality increased with increased numbers of annual herbicidal applications (McCarty, Linscott).



Effective control of rubberweed resulted one year after treatment in Arizona with 2 lb/A of propylene glycol butyl ether ester of 2,4-D. Plants were sprayed when three to five inches tall. Loco-weed (Lupinus kingii) was effectively controlled in limited tests with 1 lb/A of the ester of 2,4-D during the three to five leaf growth stage (Johnsen).

By controlling weeds in the establishment phase of forage legumes, significant yield increases were obtained. Birdsfoot trefoil yielded 2 3/4 tons dry matter per acre in the seeding year when weeds were controlled with a mixture of dalapon and 4-(2,4-DB). These chemicals in Indiana (Schreiber) and Missouri (Peters) not only significantly increased yield but increased the stand survival in the first year and allowed better developed plants more capable of surviving the first winter.

Neburon applied pre-emergence to alfalfa at 1 or 2 lb/A successfully controlled weeds without injury to alfalfa for the fourth year in Missouri (Peters).

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FORAGE AND RANGE RESEARCH BRANCH

CROPS RESEARCH DIVISION

AGRICULTURAL RESEARCH SERVICE

Title: PASTURE AND RANGE INVESTIGATIONS UNDER ARID, SEMI-ARID, AND  
SUBHUMID CONDITIONS (INCLUDING SILAGE AND HAY PRODUCTION)  
(1959 - page 142)

All of the work reported herein is cooperative with the various State agricultural experiment stations concerned; and certain phases are cooperative with the Animal Husbandry Research Division and the Soil and Water Conservation Research Division of the Agricultural Research Service and with the Forest Service, Bureau of Land Management, and Bureau of Indian Affairs.

This is a highly abbreviated report and covers only a small part of the total program in progress by the above Agency under this Work Project title. A list of the research personnel participating in this work project and their addresses is appended. Numbers in parenthesis following names refer to the numbered paragraphs of this report, to identify each paragraph with the appropriate scientists. Work is reported upon only when significant conclusions have been reached, and never in two succeeding years, unless significant additional progress has been made. Therefore, representation of any particular scientist in this report, or failure to be represented, is not necessarily an indication of his productiveness. Some of the scientists not represented in the present report will appear in reports of the respective states with whom they are cooperating closely.

Progress: 1. Range grasses respond differently to row spacing. In a 4-year study of yield from rows spaced 6 to 60 inches apart at the Squaw Butte station in southeastern Oregon, big bluegrass yielded most from 6-inch row spacing, Agropyron inerme from 12-inch spacing, A. elongatum and A. trichophorum from 24-inch spacing, and A. desertorum from 36-inch spacing. A. sibiricum yielded approximately the same at all row spacings. Except for big bluegrass row spacing affected per-acre yields much less than would be expected. During the first two years the closer spacings tended to yield more than wider spacings. During the last two years, wider spacings tended to yield more. Considering the long-life objective of range seeding, wider row spacings merit further investigation. Crested wheatgrass, in 48-inch rows, yielded only 3-1/2 per cent below 36-inch spacing, and higher than 6, 12 or 24-inch spacing. Maximum yields the first harvest year (seeded spring 1955, harvested summer 1957) were at 36-inch row spacing though not significantly above 6-inch spacing. In the second and fourth years 48-inch spacings yielded most, and in the third year 60-inch spacings. Agropyron sibiricum followed the same trend, except its highest yield the first year was with 6-inch spacing.

2. Mesquite control tough problem on Jornada. Fenuron pellets offer an effective means of killing isolated mesquite plants, particularly those less than eight feet in diameter; but spraying solid stands of mesquite with 2,4,5-T has not given satisfactory kills, in studies on the Jornada. Plants with crown diameter less than two feet, two to four feet, four to six feet, six to eight feet and above eight feet were treated with pellets having two, three, four, six and eight grams active ingredient, respectively, and yielded kills of 93.8, 88.2, 85.1, 67.3 and 38.8 per cent, respectively. Spraying with 2,4,5-T in 1958 at .18, .50 and .75 pound acid equivalent killed 11.7, 18.5 and 23.3 per cent of the plants, respectively. Plants sprayed in 1959 at .50 and .75 pounds acid equivalent suffered defoliation at 31.9 and 33.3 per cent, respectively. Plants sprayed in both 1958 and 1959 at above rates averaged 33.7% defoliated. Plants sprayed in 1958 and 1960 (.48 and .69 gm. active ingredient) averaged 41.2% defoliated. The data suggest repeat sprayings using relatively low rates.

3. Tarweed a vigorous competitor on mountain rangelands. Studies in southeastern Idaho indicate good stands of intermediate wheatgrass are obtained when tarweed is absent or sparse, while at high tarweed populations grass mortality is extreme. Spring emergence was unaffected by tarweed density, but by fall there was an inverse relation between tarweed numbers and seeded grass; and one year later both number and vigor of seeded plants were greatly reduced at tarweed populations of 16 or more plants per square foot. Tarweed frequently occurs in densities of several hundred to a thousand plants per square foot.

4. Pattern for revegetation emerging in depleted site study. Depleted sites at fairly high elevations in the mountain west are characterized by high rodent populations, require careful seedbed preparation, and are most successfully revegetated by rhizomatous species. Studies at six widely separated locations were inconsistent as to the value of transplants, the effect of chemical herbicides, the value of fertilizer, and the precise method of seedbed preparation. When tarweed is present, seedbed preparation becomes critical. Intermediate or pubescent wheatgrass were successful at five locations and were not tested at the sixth where smooth brome grass and meadow foxtail both did well. High seedling mortality, not a result of drought, appears to be caused by submergence in water during rapid spring snow melt, disease organisms, frost heaving, or extreme soil compaction.

5. Firm seedbed improves stands on loam soil. In a 3-year study at Fort Collins, Colorado, seedling emergence and establishment were increased by cultipacking the seedbed or by the use of packer wheels on the drill. For 1958, 1959 and 1960, seedlings were increased 4, 25 and 30 per cent, respectively, by one cultipacking of the seedbed prior to planting, and 16, 33 and 80 per cent, respectively, by three cultipackings, compared with no cultipacking. Two-inch wider packer wheels increased seedlings 14, 6 and 19 per cent for the three years, and 4-inch packer wheels 8, 10 and 31 per cent, respectively, compared with no packer wheels. In 1960 cultipacking and packer wheels were combined, the packer wheels running ahead of the planting discs. Seedling counts were increased 48, 18 and 4 per cent over no packer wheels



when the seedbed was not cultipacked, cultipacked once, and cultipacked three times, respectively. These results were obtained on a fine sandy clay loam soil. On a loose loamy sand at the Central Plains Experimental Range at Nunn, neither packer wheels nor cultipacking increased seedling emergence or survival.

6. Lehmann lovegrass and King Ranch bluestem adapted to seeding Arizona chaparral burns. A broadcast seeding in the ash of a chaparral burn in 1959 demonstrated the superiority of Lehmann's lovegrass and King Ranch bluestem to become established and survive in a 25-inch rainfall zone and at 3300 feet altitude in the Salt River watershed. Buffelgrass gave good initial stands but failed to survive winter temperatures. Weeping lovegrass, widely used throughout the chaparral type, gave only fair stands and is less desirable because it is short-lived and stands deteriorate rapidly. Soil on the site is a thin, gravelly, sandy loam derived from granite.

7. Mid-season nitrogen effectively lowers legume content of pasture mixtures. Application of nitrogen to pasture or hay sward in mid-season significantly lowered percent legumes in mixtures by the next harvest, the reduction being proportional to the N applied in studies on irrigated land at Bozeman, Montana. Two hundred pounds N applied following the June 20 harvest lowered percent legumes by July 25 from 76 to 56% in an alfalfa + grass mixture; 69 to 42% in a red clover + grass mixture; 53 to 22% in an alsike clover + grass mixture; and 54 to 21% in a birdsfoot trefoil + grass mixture. Reductions of the same magnitude persisted into the fourth harvest made September 8. Reduction in percent legume through mid-season N application stimulated grass and increased total yield. Average late season yields for all mixtures, with 0, 50, 100, and 200 pounds N applied mid-season were 1.63, 1.96, 2.22 and 2.62 tons/acre. Mid-season application of N one year did not alter species populations.

8. Medusahead rye is palatable in vegetative stage. A study in Mendocino County, California, has shown that sheep graze medusahead rye in the vegetative stage to about the same extent as other species with which it is associated. However, when headed out, palatability drops rapidly, relative to associated vegetation. The experimental pastures consisted of 76% medusahead in February, dropping to 45% on unfertilized plots and 35% on fertilized plots after heading out. Forage samples obtained from esophageal fistulated Corriedale wethers indicated 50% of the forage consumed was medusahead during February, March and April, dropping to 25% in June. After heading out, the fertilized plots (35% of total forage) provided only 11% of the fistula sample.

9. Yearling steers not sensitive to coumarin content of sweet clover. In studies at Mandan, North Dakota, 10 varieties of sweet clover were grazed with approximately equal relish by steers although blister beetles and jack rabbits preferred the low coumarin lines. Varieties included Denta (w 31), N 15, W-7, Goldtop and Madrid. The plots were planted in May 1959 and grazed in June 1960 when growth was 10 to 18 inches. After five days of grazing all varieties had been utilized to a 5-inch stubble height. Goldtop and Madrid, both high coumarin varieties, were grazed heaviest during the first day.



10. Low level stilbestrol implants increase steer gains. Yearling steers at Woodward, Oklahoma, given 12-milligram stilbestrol implants November 1, gained 15 pounds more per head during the winter than steers not given implants. Steers given similar implants May 1 gained 28 pounds more per head during the summer than controls. When implants were given both on November 1 and May 1, steers gained 45 pounds each per year over the non-implanted group. The 12-milligram (low level) implant thus increases gains and avoids undesirable side effects sometimes experienced with implants containing 24 or 36 milligrams stilbestrol.

11. Physiology of crested wheatgrass provides flexibility in management. Crested wheatgrass, in response to management practices, will produce a crop of vegetative culms which retain their leaves and can be grazed at any time during the season, according to recent studies at the Squaw Butte Station in southeastern Oregon. The first growth of crested wheatgrass in the spring is almost entirely reproductive culms and has given rise to the concept of heavy spring use to prevent formation of stemmy, unpalatable forage. But fairly heavy grazing about mid-May removes the growing point and stops further development of reproductive culms. If grazing is discontinued then, an entirely new crop of primordia develops (except in very dry years), producing only vegetative culms. This knowledge makes possible increased flexibility in the utilization of crested wheatgrass and enhances its value throughout the arid west.

12. Species density and yields of forage fluctuate greatly on Jornada. Density of black grama and sand dropseed, and canopy of mesquite changed markedly in response to precipitation during 1958-60, and forage yields were influenced, on the major sandy soils of the Jornada. Black grama density increased 54%, decreased 52%, and decreased 51% for 1957-58, 1958-59, and 1959-60, respectively, leaving the 1960 density only 23% of the 1958 density. For the same period, sand dropseed increased 5%, decreased 21% and decreased 56%, ending in 1960 with 35% of its 1958 density. Mesquite remained unchanged, increased 57%, and increased 9%, ending in 1960 with a canopy 171% of the 1958 canopy. For the same 3-year period, yield of the black grama site was 287, 392 and 111 pounds air dry herbage per acre and of the dropseed-dominated site 180, 269 and 68 pounds. These data emphasize the necessity for a flexible pattern of management to meet the environmental variations.

13. Jornada environment unfavorable for range seeding. Most summers on the Jornada rain storms are adequate to germinate seeds of black grama, and seedlings emerge, but die of drought before the next storm. In 1958, .55 inch precipitation on July 29 provided four days available moisture at 1/2 inch depth, and eight days at 4-inch depth. Black grama germinated and emerged but died before the next precipitation August 21-24 when 2.25 inches produced favorable conditions for 12 days. Again black grama emerged but died before the next storms in September. In 1959, precipitation in mid-July resulted in germination and emergence of black grama, but the seedlings died before 2.51 inches of precipitation came on August 8. This precipitation resulted in germination and emergence of black grama and was supplemented shortly with fairly continuous favorable moisture until August 28. However, the seedlings died before the next storm in September. In 1960, summer



precipitation was so low that no black grama emergence was observed. Temperatures in the surface inch of soil are frequently above 120° F., which is considered a cause of high seedling mortality. Failure of roots to penetrate the soil as rapidly as moisture is lost from this sand flats range site may be another factor.

14. Range grasses germinate differentially in response to moisture stress. Black grama was least affected, and Mesa dropseed most sensitive to varying moisture stresses provided by Mannitol solutions, in studies conducted at Las Cruces, New Mexico. Seeds were germinated at concentrations ranging from 0.3 to 20 atmospheres at 25° C. (77° F.). After 108 hours black grama had germinated 93.5% at 0.3 atm. and 54% at 20 atm.; Bush Muhly 99 and 17%; tobosa 98 and 6%; Boer lovegrass 32 and 0.5%; Lehmann lovegrass 97.5 and zero (11% at 15 atmospheres); and Mesa dropseed 50 and zero (11.5% at 7 atmospheres). Black grama declined gradually as osmotic concentration increased; Bush Muhly and tobosa held up well through 7 atmospheres and then dropped abruptly; Lehmann lovegrass dropped abruptly between 3 and 7 atmospheres and again between 7 and 11 atmospheres. Assuming a low viability of the seed used, Boer lovegrass declined gradually and Mesa dropseed dropped abruptly between 3 and 7 atmospheres.

15. Helminthosporium sp. attacks range grass seeds. Seeds of crested and intermediate wheatgrass and smooth brome grass were heavily infected, native slender wheatgrass and mountain brome moderately infected, and wild oats, barley and alfalfa uninfected by Helminthosporium sp. when fall planted in nylon bags at 5500 feet altitude at Ephraim, Utah, and examined the following spring. Infection was highest at the 2, 1, and 1/2 inch depths of planting with smooth brome grass having 96, 77 and 55 per cent respectively of its seeds infected. Late fall plantings tended to be freer of infection than early fall. Seeds treated with Orthocide 75 at recommended rates were rarely infected. Infection was less at 7000 feet and absent at 8850.

16. Range forage predictable from precipitation data. Studies at Burns, Oregon, have shown that accumulated precipitation records for an area are a valuable basis for predicting forage yields from arid grazing lands from which a minimum of yield data is available. Yield and precipitation potentials were calculated for 13 sets of data from Oregon, Utah and Idaho. When expressed in percent, these potentials become indices, regarded as ecologically equivalent. Based on the data from 13 series (N=94), expressing the general relationships of yield to precipitation, the regression was  $Y = 1.11, X = 10.6$  and the correlation of yield x precipitation was +.880.

17. One harvest gives maximum yields of native range. Harvesting once, on August 1, yielded more than harvesting June and August 1, or June 1, July 1 and August 1, in a 3-year study at Mandan, North Dakota. Plots harvested only on August 1 each year yielded 1496, 480 and 1621 lb/acre for 1958, 1959 and 1960, respectively. Cut twice a year, comparable yields were 1027, 304 and 1104, the one harvest being significantly more than the 2-harvest for each year. Harvesting three times a year was not significantly different from two harvests.

18. Unbiased yield data require surface harvest. Studies at Mandan, North Dakota, 1957-60, on native range, have shown that season and treatment materially influence the percentage of total growth that is measured with clippings at a 1-inch height, and that for reliable comparative data, yields must be based on surface clipping. Harvests made in August (4-year aver.) at one inch, gave yields of 506, 1105, and 1468 lb/acre for zero N, 30 N and 90 N/acre, respectively. The same treatments, surface clipped, yielded 1235, 1860 and 2148 lb/acre. Thus, 61% of the total yield of the zero-N plot was below one inch. For 30 N and 90 N treatments, the percentages below one inch were 44 and 37, respectively. In the dry year of 1959, 77, 70, and 62% of total growth was below one inch for the zero N, 30 N and 90 N, respectively. In the normal year of 1960, corresponding values were 54, 21, and 20%. In 1960, on May 1, from 97 to 99% of growth was below one inch regardless of treatment. By July 15, 64% of the zero-N plot was below one inch and 24% of the 90 N plot.

19. Powder measures accurately meter seeds of many species. Of three adjustable powder measures tested at Fort Collins, Colorado, two proved satisfactory for metering small quantities of seed for use in a cone seeder, but chaffy or awned seeds could not be metered. When set to discharge 1000 seeds, by weight, the coefficient of variation for 25 discharges ranged from 0.3 to 3.9%. Set for 100 seeds the coefficient of variation was 1.1 to 17.8%. Small, awnless, free-flowing seeds were most accurately measured.



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<sup>1</sup>Retired January 1961.

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<sup>3</sup>On Fulbright in Turkey - January to October 1961.

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<sup>1</sup>Resigned June 30, 1961. Now at University of California at Riverside.

<sup>2</sup>Resigned April 15, 1961 to enter commercial field.



WESTERN SOIL AND WATER MANAGEMENT RESEARCH BRANCH

SOIL AND WATER CONSERVATION RESEARCH DIVISION

AGRICULTURAL RESEARCH SERVICE

Title: HYDROLOGY OF SEMI-ARID AREAS AS INFLUENCED BY CHARACTERISTICS OF SOILS AND VEGETATION

Leaders: J. L. Gardner, Joel E. Fletcher, Robert V. Keppel and Kenneth Renard, Agricultural Research Service, Headquarters at Tucson, Arizona

- Objectives:
1. To determine the precision of sampling of native vegetation and accompanying soils necessary to allow detection of differences that will affect runoff and sediment movement.
  2. To test methods of measuring native vegetation and accompanying soils appropriate to watersheds of different sizes.
  3. To develop or adapt methods for evaluating the effects of riparian vegetation and accompanying soils on movement of runoff and sediment in ephemeral stream channels.
  4. To sample and evaluate the interrelations of native vegetation and soils.

Progress: On the 58-square-mile Walnut Gulch drainage area at Tombstone, Arizona, a standard soil survey has been made, range site and condition have been mapped, simultaneous sampling of the soil and the vegetational cover has been completed, and the soil samples have been analyzed in the laboratory. The area is one of desert plains grassland, about two-thirds of which has deteriorated to desert shrub dominated mainly by white thorn (Acacia constricta var. vernica), tarbush (Flourensia cernua), and creosotebush (Larrea divaricata). Many of the soils and vegetation data have been analyzed statistically. Correlation of kind and amount of vegetational cover has been demonstrated with dominant species, soils series, parent geologic material, and certain physical and chemical characteristics of the soil, such as pH, carbonates, nitrates, phosphates, moisture equivalent, etc. In general, correlation coefficients are low, but many are statistically significant. For example, for total shrub cover with pH of the surface horizon,  $r = +0.340$ ; with carbonates,  $r = +0.385$ ; with phosphates,  $r = -0.284$ ; and with moisture equivalent of the crust (i.e., the surface 0.25-0.50 inch),  $r = -0.394$ . Corresponding values for total basal area of grasses were: with pH,  $r = -0.466$ ; with nitrates,  $r = -0.157$ ; with carbonates,  $r = -0.463$ ; with phosphates,  $r = +0.206$ ; and with moisture equivalent of the crust,  $r = +0.268$ . (For  $r = 0.154$ ,  $P = 0.05$ ; for  $r = 0.204$ ,  $P = 0.01$ ) Basal cover of the main grass dominant, Bouteloua eriopoda, which is probably the true climax dominant over most of the area, is significantly correlated with none of these soil factors. The low but significant negative correlation of total grass cover with nitrates is interpreted as signifying that nitrates are in short supply, and,

in soils supporting higher amounts of grass cover, they tend to be used almost as rapidly as they are formed. This hypothesis is supported by the marked response in growth observed when nitrate is applied to well-grassed areas on these ranges. A treatise embodying the results of these studies is in preparation.

On the 65-square-mile Alamogordo Creek drainage area near Santa Rosa, New Mexico, a standard soil survey and a range site and condition survey have been completed; but the area has not as yet been sampled to study the interrelations of the soil and the vegetation.

Title: FERTILITY EXPERIMENTS ON NATIVE ANNUAL RANGE (1959 - page 155)

Leader: Ralph E. Luebs, Agricultural Research Service, Soil and Water Conservation Research Division, Riverside, California

Objectives: 1. To determine the nitrogen fertilizer requirements for optimum production of native annual range plants.

2. To determine the need for phosphorus and sulfur application on annual native range.

Progress: Investigations are conducted in southwestern Riverside County, California, at an elevation of 2,000 feet in the coastal range. Annual rainfall averaging 20 inches occurs during the winter months. The principal species constituting the annual native range are alfilaria (Erodium botrys); wild oats (Avena fatua); ripgut brome (Bromus rigidus); and soft chess (Bromus mollis).

With 16.5 inches of rainfall during the 1959-60 season, forage production was increased over 100 per cent on sloping range sites by the application of 60 pounds of nitrogen and phosphorus at 60 pounds  $P_2O_5$  per acre. Nitrogen alone at the above rate increased yield 60 per cent, while phosphate alone was of no benefit. Actual yield increases at different sites on slopes ranged from 1,100 to 1,700 pounds of dry forage per acre for the 60-60-0 treatment. At a swale site, the combined application of nitrogen and phosphorus produced the greatest increase in yield. This increase in dry matter was comparable to increases obtained at sloping sites, although the percentage increase was less. One hundred twenty pounds of nitrogen were greatly superior to 60 pounds at the swale site, but not on the slopes. Production was increased over 500 pounds per acre at the swale site by sulfur applied as gypsum with nitrogen and phosphorus fertilizers.

Beef gains on nitrogen-fertilized and nonfertilized range were compared during the 1959-60 grazing season. Sixty pounds of nitrogen were applied. The length of the grazing period was 82 days. The beef gain per acre was 145 pounds on the fertilized range and 77 pounds on the nonfertilized range. The increased return per acre from the fertilized range, after deduction for costs of fertilizing, exceeded ten dollars.



Title: VALUE OF SUBSOIL OPERATIONS AND NITROGEN FERTILIZERS ON  
RANGELAND IN SOUTHEASTERN IDAHO

Leader: Truman Masee, Agricultural Research Service, SWCRD,  
St. Anthony, Idaho

Objectives: To determine the value of subsoil operations for increasing moisture storage during winter and the value of nitrogen fertilizer for increasing the value of rangeland.

Progress: This trial was initiated in the fall of 1960, and treatments were applied at this time. Variables include the following:

1. Check
2. Rotary subsoil in fall
3. Nitrogen @ 100 lb/A
4. Rotary subsoil plus 100 lb. N/A
5. Reseed range to improved grass species (done in spring, 1961)

Future Plans: Moisture storage, forage production and ground cover will be measured at successive intervals of this trial. Attempts will be made to increase ground cover on depleted rangeland whereby precipitation is more fully utilized and runoff from snow melt in the spring is minimized.

Title: SOIL CHANGES RESULTING FROM FOUR YEARS OF FERTILIZER  
APPLICATION ON NATIVE RANGE

Leaders: Paul L. Brown, Glennis O. Boatwright, David D. Dickey, Agricultural  
Research Service, SWCRD, and Fred B. Gomm, CRD, Bozeman, Montana

Objectives: 1. To determine total nitrogen content of soil as influenced by single and repeated N and P fertilizer treatments.

2. To determine available soil phosphorus resulting from single and repeated fertilizer treatments.

3. To determine organic matter in order to detect organic matter changes in the soil as influenced by single and repeated fertilizer treatments.

4. To add supplemental water to small subplots to establish two soil moisture levels in order to determine the yield potential resulting from residual effects of fertilizer treatments.

Progress: Stitt and Gomm<sup>1</sup> initiated uniform fertility studies at four locations in southeastern Montana in 1956. The original study was designed to determine the effect of fertilizer treatment on herbage yield, vegetal

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<sup>1</sup>Fred B. Gomm. Annual Progress Report. Cooperative Forage and Range Investigation, Crops Research Division, Bozeman, Montana. 1956.

composition of the cover, morphological differences with species and nutritive composition. The soil phases of this study were initiated in 1961 on two of the four sites.

One site is a deteriorated range with vegetation of the bluegrass-stipa-wheat-grass-blue grama-sedge complex. The soil has been tentatively identified as Wheeler silt loam of the Brown soil group. Annual precipitation is 8 to 10 inches. On the second site, vegetation is an Idaho fescue-wheatgrass complex. The soil is a silt loam high in organic matter. The series has not been identified. Annual precipitation is about 20 inches.

Fertilizer applications consisted of five rates of nitrogen and three rates of phosphorus in all combinations. Main plots were subdivided to study annual and residual applications of one, two, three and four years of fertilizer application. The last fertilizer applications were made in 1959. Gomm will report results from the original study.

Soil samples for laboratory analysis were taken in the spring of 1961 at both sites. Supplemental water was added only on the low rainfall-deteriorated range site.

Future Plans: Analyze soil samples within the next year. Results of the analyses will influence further studies on range soils.

Title: RUNOFF STUDIES FROM SINGLE CROP AGRICULTURAL WATERSHEDS

Location: Hastings, Nebraska

Objectives: To evaluate the effect of (1) different land use treatment, and (2) different crops on the runoff from single soil and single crop watersheds in the Central Great Plains, as one of the significant factors influencing runoff from complex watersheds.

Progress: One of the three native grass watersheds is pasture. (The other two are meadow.) The first watershed was established in July 1939 and except for a break in records from about August 1, 1955 to December 1956 is continuous to date.

Title: RUNOFF STUDIES ON CULTIVATED LAND RE-SEEDED TO GRASS

Location: Hastings, Nebraska

Objective: To determine the effect of seeding cultivated land to grass on runoff.



Procedure: Watersheds 22-H and 23-H<sup>1</sup> are being established in 1961 to obtain rainfall records on and runoff records from 4-acre, cultivated watersheds which have been reseeded back to grass.

Title: INFLUENCE OF SOIL MOISTURE AND FERTILITY ON SIDEOATS GRAMA SEED PRODUCTION

Leader: D. E. Smika, Soil and Water Conservation Research Division, Agricultural Research Service, North Platte, Nebraska

Objectives: 1. To determine the effect of various commercial fertilizer treatments and soil moisture treatments on: (a) forage and seed yield, (b) total water use, (c) fertilizer recovery and efficiency of use.

2. To determine the effects of climatic factors on total water use and water use by phenologic period.

Progress: This study was initiated in April of 1961, and no results have been obtained.

Title: EFFECT OF PLACEMENT OF FERTILIZER ON GROWTH OF GRASS  
(1959 - page 158)

Leaders: D. E. Smika and H. J. Haas, SWCRD, cooperating with G. A. Rogler and R. J. Lorenz of the Crops Research Division, Northern Great Plains Field Station, Mandan, North Dakota

Progress: Yields of both grasses show that there is no advantage to placing fertilizer four inches deep compared to broadcasting on surface. There is, however, some cultivation effect from the drill alone on improving the yields, but no greater response to the fertilizer.

One spray application of 2,4-D ester has been effective in controlling the sage for three years. When the sage growth was eliminated by spraying, increases in yield were obtained as a result of the spraying.

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<sup>1</sup>United States Department of Agriculture, Agricultural Research Service, Monthly Precipitation and Runoff from Small Agricultural Watersheds in the United States, pp. 44.26-1 and 44.27-1.

Title: EFFECT OF FERTILIZATION IN CLIPPING TREATMENTS ON MOISTURE USE OF NATIVE RANGE (1959 - page 158)

Leaders: D. E. Smika, H. J. Haas and J. F. Power, SWCRD, cooperating with G. A. Rogler and R. J. Lorenz, Crops Research Division, Northern Great Plains Field Station, Mandan, North Dakota

Progress: Clipping frequencies and clipping heights have had no consistent effect on soil moisture; however, fertilized plots have generally been drier at harvest than non-fertilized plots.

Title: ANNUAL AND RESIDUAL EFFECTS OF FERTILIZERS ON YIELD AND COMPOSITION OF NATIVE GRASS AT TWO SOIL MOISTURE LEVELS (1959 - page 159)

Leaders: D. E. Smika, H. J. Haas and J. F. Power, SWCRD, cooperating with G. A. Rogler and R. J. Lorenz of the Crops Research Division, Northern Great Plains Field Station, Mandan, North Dakota

Progress: With increasing fertilizer and increasing soil moisture, yields of native grass are increased.

Total seasonal moisture use is increased with increasing soil moisture, but is not affected by fertilizer. Moisture use efficiency is higher with increased fertility and with increased soil moisture.

Moisture use rate and production rate are very closely related throughout the entire growing season. Production rate per inch of water used consistently increased with increasing nitrogen fertilizer irregardless of soil moisture condition for all fertilizer treatments.

Title: RUNOFF CHARACTERISTICS OF AGRICULTURAL AREAS IN THE RED PRAIRIES OF OKLAHOMA

Leader: W. O. Ree

Objectives: 1. To determine the rates and amounts of runoff from small watersheds in the agricultural areas of the Red Prairies in Oklahoma.

2. To determine the relationship between precipitation and runoff for these watersheds.

Progress: Nine years of record are available for rainfall on and rainfall from three small watersheds in native grass rangeland in the Red Prairies of Oklahoma. A limited photographic record has been kept of range condition. However, this part of the study was not emphasized since the main consideration in the experiment was the evaluation of the techniques used in runoff management.



Title: THE EFFICIENCY OF BROADCAST VERSUS DRILLED SUPERPHOSPHATE ON THE NUTRIENT UPTAKE BY AN ESTABLISHED STAND OF CRESTED WHEATGRASS (1959 - page 150)

Leaders: H. R. Cospers, A. Alsayegh, Agricultural Research Service, Newell Irrigation and Dryland Field Station, Newell, South Dakota.  
Cooperating with the South Dakota Agricultural Experiment Station

Progress: This study was established in the fall of 1959 on a Pierre clay soil which has an average clay content (0.002 - 0 mm.) of 54 per cent to a depth of 20 inches.

The application of phosphorus fertilizer, broadcast or drilled, alone or in combination with nitrogen, significantly increased the phosphorus content of the crested wheatgrass forage. One year's data indicated no significant difference in phosphorus uptake by the crested wheatgrass between broadcast and drilled phosphorus.

Nitrogen fertilizer applied alone or in combination with phosphorus broadcast or drilled significantly increased the nitrogen percentage in the forage. Evidence obtained in the 1960 season indicates the ripping action of the chisels in drilling the phosphorus may have influenced the nitrogen uptake by the crested wheatgrass.

Precipitation during 1960 was less than one-half the longtime average. Forage yields of crested wheatgrass were not significantly increased by the application of fertilizer because of limited moisture. Also, no re-establishment of roots disturbed by the drilling of phosphorus was obtained. Moisture use efficiency was greater from broadcast nitrogen and phosphorus fertilizer than broadcast nitrogen with drilled phosphorus.

Title: EFFECT OF FERTILIZATION ON THE YIELD AND NUTRITIVE VALUE OF NATIVE GRASSES UNDER DRYLAND CONDITIONS OF WESTERN SOUTH DAKOTA AND EASTERN WYOMING (1959 - page 152)

Leaders: H. R. Cospers, A. Alsayegh, Agricultural Research Service, Newell Irrigation and Dryland Field Station, Newell, South Dakota, and James C. Larsen, Soil Conservation Service, Sundance, Wyoming

Progress: This study was established in the fall of 1957 and concluded in 1960. Immediate and residual effects of applied fertilizer on native range vegetation were determined. The various rates of nitrogen and phosphorus fertilizers were applied at three periods of the year on this range site with a silt loam soil texture. The periods for fertilizer application were fall, spring, and summer.

The single application of fertilizer significantly increased total forage production for three years. The mean percent of nitrogen recovered for all rates and combinations of nitrogen applied, for all seasons of application, was

36.7 per cent. The greatest mean percent of nitrogen recovered for all rates and combinations of nitrogen for each season of application was 46.7 per cent from fall-applied fertilizer. Increases in yield and protein content of the forage were significantly correlated for each year.

The greatest increase in total forage production resulted from fall- or spring-applied fertilizer. The greatest increase in non-grass forage for three years, as a result of a single fertilizer application, came from the fall-applied fertilizer, and the least increase from the summer-applied fertilizer. The greatest increase in total grass forage for three years came from the fall-applied fertilizer, and the least increase was obtained from the spring application.

Title: THE INFLUENCE OF FERTILIZER RATES, MOISTURE AND RANGE PLANT COMPETITION ESTABLISHING RANGE VEGETATION (GP-6)

Leaders: H. R. Cospers, A. Alsayegh, Agricultural Research Service, Newell Irrigation and Dryland Field Station, Newell, South Dakota.  
Cooperating with the South Dakota Agricultural Experiment Station

Objectives: 1. To evaluate the influence of starter fertilizer, moisture and their interrelationship on establishing new grass stands, with and without competition from existing range vegetation.

Progress: This study was initiated in the spring of 1961 to evaluate the influence of the various factors on seedling establishment. Western wheatgrass was seeded with and without competition from an existing stand of crested wheatgrass. The great cost and effort needed in reseeding deteriorated stands of range vegetation are discouraging to the rancher because of the unpredictable results.

The purpose of this study is to provide information concerning agronomic practices related to seedling establishment in the Northern Great Plains area. Data will be obtained in 1961 on stand establishment, forage yields and chemical composition of the Western wheatgrass forage. Observations will also be made in 1962.

Title: THE RATE OF NITROGEN RECOVERED FROM SEVERAL LEVELS OF APPLIED NITROGEN FERTILIZER BY AN ESTABLISHED GRASS STAND

Leaders: H. R. Cospers, A. Alsayegh, Newell Irrigation and Dryland Field Station, Newell, South Dakota, and L. K. Porter, B. A. Stewart, Nitrogen Laboratory, Fort Collins, Colorado, Agricultural Research Service. Cooperating with the South Dakota Agricultural Experiment Station

Objectives: 1. To study and evaluate nitrogen recovery from various levels of applied nitrogen using an established stand of crested wheatgrass.



2. To determine what happens to the soil-applied nitrogen with time.

3. To determine soil moisture utilization from the different rates of applied fertilizer at two soil moisture levels.

4. To demonstrate maximum forage yields that may be produced under conditions of optimum moisture and fertility.

Progress: Results obtained the first year of this study indicate the use of nitrogen fertilizer greatly increased the nitrogen percentage in the crested wheatgrass forage. The use of supplemental water increased the nitrogen recovery and nitrogen use efficiency. The most efficient use of nitrogen with and without supplemental water was made from the application of 40 pounds of nitrogen. Without the addition of supplemental water, the amount of nitrogen recovered from that applied decreased as the rate applied increased.

Analysis of the soil for total nitrogen one cropping year after the nitrogen fertilizer was applied indicates little downward movement of applied nitrogen below a 6-inch depth.

The maximum yield produced was slightly more than 5000 pounds per acre of oven dry forage. To produce this forage yield, 640 pounds of nitrogen fertilizer were applied with 14.83 inches of supplemental water. The residual effect of applied fertilizer will be studied in 1961 and 1962.

Title: RUNOFF, SEDIMENTATION, POND WATER LOSSES, PRECIPITATION, VEGETATION, AND TRANSMISSION LOSSES ON RANGELANDS OF THE NORTHERN PLAINS

Leaders: A. R. Kuhlman, J. W. Neuberger, ARS, SWCRD, Newell, South Dakota

Objectives: 1. To determine yields of runoff and sediment from small range-land watersheds.

2. To determine characteristics of precipitation in Northern Great Plains.

3. To determine influence of vegetal cover on runoff and sedimentation on small grassland watersheds.

4. To study seepage and evaporation losses from small stock ponds.

5. To study transmission losses in valley alluviums above and below stock water structures in the Northern Plains.

Progress: Studies on hydrology were started in March 1957. Three and one-half years' data are available on 16 grassland watersheds ranging from 30 to 13,000 acres. Resurveys for sedimentation data are underway on four ponds in 1961.

Calculation of sediment yields shows various results. The measured sediment yield from a 815-acre watershed of lighter textured soils averaged 2.3 acre feet per square mile annually for a 6-year period. Ninety per cent of this sediment was deposited within 60 per cent of the distance upstream from the dam. A majority of the sediment accumulated at the deepest point of the reservoir.

During the 4-year period, data show that 72 to 100 per cent of all runoff has occurred from snowmelt on small rangeland watersheds having predominantly silty soils, and 44 to 86 per cent from those with clay soils. In the Northern Plains, snow accumulation is affected greatly by winds. Studies have been initiated to evaluate the effects of drifting upon the accumulation of snow, as related to watershed aspect and surface configuration. Snow staffs arranged in courses are being used to measure snow accumulation at five watersheds. Moisture content of snow is determined before periods of thaw.

Annual runoff has been quite variable. During the period of experimentation the highest runoff has been 2.65 inches on a 90-acre watershed after 11.2 inches of precipitation. In 1958, a storm totaling 3.17 inches in 253 minutes produced 0.96 inches of runoff from a 45-acre watershed. For this storm, a 30 minute precipitation intensity of 2.14 inches was recorded. However, this intensity exceeds 100 year expectancy. Annual runoff could be negligible. One large storm may produce over one-half of the annual runoff. Many storms are common in the area. Precipitation data is gathered at 44 recording gages, located at one or more points on the various watersheds.

Drought and cracking of clay soils deterred runoff. Cracks up to 0.7 foot wide and as much as 60 feet long were photographed in 1960. Silty soils including Cushman and Bainville developed shrinkage cracks up to one-half inch wide. That year watersheds having silty soils produced only a trace to a maximum of 0.16 inch of summer runoff, as compared to 0.05 to 0.82 inch for those watersheds having clay soils such as Pierre and Lismas. Soil moisture data, taken weekly to a six inch depth and monthly to three feet, are available in assessing factors in runoff.

Dissipation of stored reservoir water by seepage and evaporation may be twice as great as the runoff for a particular year. In 1960, 17 acre feet of water were lost from one reservoir where the surface area was approximately 2.6 acres and the depth averaged 14.8 feet for the year.

Vegetal data, being gathered, include: clipping of cover for volumes of herbage, mulch, and humic mulch; reading line transects biennially; wheel-point data (after Tidmarsh and Havenga); degree of use by livestock; and range condition at various range sites on the watersheds. Total cover on a range site may be up to 4,500 pounds per acre. Short grasses abound in the area.



Rainfall simulator or infiltrometer studies were conducted by Frank Rauzi on part of the watersheds in 1957 and 1958. Two or more watersheds will be studied in 1961.

Title: MACHINERY FOR PASTURE ESTABLISHMENT AND MAINTENANCE

Leaders: Elmer B. Hudspeth, Jr., and Richard Dudley, Agricultural Research Service, AERD, Bushland, Texas. Cooperating with Wayne G. McCully, Texas Agricultural Experiment Station; Norman Welch and Earl Burnett, Agricultural Research Service, SWCRD, Big Spring, Texas

Nature of Research: Equipment and methods of establishing stands of native grass on abandoned cropland rangeland.

Progress: Starter fertilizer placed one inch to the side and one inch below the grass seed aids in stand establishment on Amarillo fine sandy loam soils. This is true for grasses like green sprangletop and Plains Bristlegrass. The starter fertilizer did not seem to benefit the bluestems.

Range pitting and seeding--the forage production on rangeland with good cover cannot be expected to be increased by pitting or listing in a year without runoff.

Better stands of grass were established with a planter equipped with 18-inch sweeps, spaced on 40-inch centers, to remove existing vegetation than by seeding in grass and weeds.

Title: EFFECT OF MOISTURE LEVELS AND FERTILITY STATUS ON THE ESTABLISHMENT OF SELECTED GRASS SPECIES (1959 - page 162)

Leaders: N. H. Welch, Earl Burnett, G. L. Randel, Agricultural Research Service, SWCRD, Big Spring, Texas, and E. B. Hudspeth, Agricultural Research Service, AERD, Bushland, Texas

Progress: From 1957-1960, low rates of fertilizers (10-20 pounds per acre of nitrogen and phosphorus singly and in combination) were banded close to the seed to determine their effect on seedling emergence and plant growth. In 1957 and 1958 two fertilizer placements were included, and in 1957 weed control versus no weed control was compared.

Results from the four years are summarized briefly as follows:

Seedling emergence was not affected by either fertilizer treatment or placement. Weed competition reduced seedling emergence on all treatments. However this reduction was no greater on the fertilized plots than on the check plots. The ease of establishment of the various grasses was directly related to the inherent seedling vigor of the particular species. Species with medium and high seedling vigor were relatively easy to establish, while those with low seedling vigor were more difficult to establish.

The growth response of the various grasses to fertilizer also appears to be directly related to the inherent seedling vigor of the particular species. Significant increases in seedling growth of species with medium and high seedling vigor were obtained on the nitrogen and nitrogen-phosphorus combination treatments. The most consistent growth increase on these species in all years was on the nitrogen-phosphorus combination treatment. No positive response to fertilizer has occurred on species with low seedling vigor. However, slight detrimental effects have been observed.

There was no difference in response between fertilizer placed one inch below the seed and that placed one inch below and one inch to the side of the seed.

Weed competition reduced seedling growth on all fertilizer treatments except the nitrogen and nitrogen-phosphorus combination treatments. The response to fertilizer on these treatments was apparently great enough to offset the detrimental effect of weed competition.

Future plans are to evaluate the effect of fertilizer on seedling emergence and growth of several grasses on typical range sites of the High and Rolling Plains of Texas.

Title: FORAGE PRODUCTION POTENTIAL OF BLUE GRAMA (BOUTELOUA GRACILIS) AND SUDAN (SORGHUM SUDANENSE) WITH ADEQUATE WATER AND NITROGEN (1959 - page 154)

Leaders: O. R. Lehman, W. C. Johnson, J. F. Cherry, Agricultural Research Service, SWCRD, Bushland, Texas. Cooperating with G. F. Ellis, Jr., Texas Agricultural Experiment Station

Progress: Applied nitrogen materially increased dry matter yields of both blue grama and Sudan. However, dry matter yields of Sudan were much greater than those of blue grama.

Pounds of dry matter produced per inch of water use were greater with Sudan than with blue grama. Applied nitrogen greatly increased the water use efficiencies of both grasses.

Total nitrogen uptake was much greater with Sudan than with blue grama. Sudan was almost twice as efficient as blue grama in utilizing applied nitrogen.

Future Plans: The results emphasize that blue grama is very inefficient in utilizing soil moisture and nitrogen. A similar evaluation of improved introduced and native grasses is planned for the future.



Title: INFILTRATION STUDIES ON SOILS WITH VARYING AMOUNTS AND KINDS OF COVER (1959 - page 156)

Leader: Frank Rauzi, Agricultural Research Service, Laramie, Wyoming

Progress: During the month of October 1960, water-intake studies were conducted at the Archer substation near Cheyenne, Wyoming. Tests were conducted on native pastures mechanically treated in the spring of 1955, with a range pitter, sod drill and the Wyoming range seeder. Tests were also conducted on non-treated pastures that have been moderately grazed since 1942.

Average water-intake rates during the 1-hour test and total cover present at the time of test are as follows:

| <u>Pasture treatment</u> | <u>Water-intake<br/>inches per hour</u> | <u>Average pounds per<br/>acre total cover</u> |
|--------------------------|---|--|
| Pitted                   | 2.02                                    | 1,218  |
| Wyoming range seeder     | 1.40                                    | 2,381  |
| Sod drill                | 0.82                                    | 1,686  |
| Moderately grazed        | 0.75                                    | 1,205  |

Detention storage by the pits and the furrows from treatment made by the range pitter and the Wyoming range seeder plus greater infiltration results in holding water that might be lost to runoff during a high intensity rainstorm.

Title: ANNUAL PASTURES FOR WYOMING DRYLAND (1959 - page 157)

Leaders: Frank Rauzi, Agricultural Research Service. Cooperating with Robert L. Lang, Department of Range Management, University of Wyoming

Progress: A combination of three annual pastures (winter wheat, oats and corn) were grazed for a total of 389.4 sheep-days per acre. A total of 1,282 pounds of lamb or 107 pounds of lamb gain per acre was obtained from the three annual pastures during 1960. Corn was substituted for the annual legume because of poor results obtained last year. The corn was grazed upon attaining 24 inches in height. The pasture seeded to sweet sudan was not grazed because of toxic amount of hydrocyanic acid present in the forage. Thus, the sudan was cut for hay and fed during the winter.

Title: THE EFFECT OF VARIOUS AMOUNTS AND DATES OF APPLICATION OF  
NITROGEN FERTILIZERS ON NATIVE SHORTGRASS RANGELAND  
(1959 - page 157)

Leaders: Frank Rauzi, Agricultural Research Service. Cooperating with  
Robert L. Lang, Department of Range Management, and L. I. Painter,  
Department of Soils, University of Wyoming, Laramie, Wyoming

Progress: Annual and seasonal precipitation at both the Archer and Gillette substations during 1960 was below their longtime average. Thus, there was no significant difference in yield of blue grama grass between native range plots that received 33 or 66 pounds N per acre and the yield from the check plots at both the Archer and Gillette substations. It appears that in years of sub-normal precipitation that yields of shortgrasses are depressed by the addition of nitrogen.



DIVISION OF RANGE MANAGEMENT AND WILDLIFE HABITAT RESEARCH

FOREST SERVICE

Range management research in the Western States is conducted by four regional forest and range experiment stations of the Forest Service located at Portland, Oregon; Berkeley, California; Ogden, Utah; and Fort Collins, Colorado. This research is concerned with improvement and management of forage resources of forests, woodlands, and related nonforest ranges and includes fundamental research to provide a better understanding of characteristics and requirements of vegetation as well as applied studies of grazing management, improvement practices, and their relation to other land uses and values. Much of this research involves cooperation in its planning and conduct with the Agricultural Research Service, Soil Conservation Service, Bureau of Land Management, Bureau of Indian Affairs, Fish and Wildlife Service, colleges and universities, State experiment stations and extension services, State fish and game departments, private organizations, and stockmen.

This report includes brief statements of progress for only a few of the studies that are being conducted in each Work Project. The name of the scientist concerned with each study is indicated. A list of range research personnel at each station is also included. Although the men are stationed at various locations within the station territory, communications addressed to the individual at the appropriate station headquarters will reach him promptly.

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Title: CHARACTERISTICS AND REQUIREMENTS OF VEGETATION ON FOREST AND RELATED RANGES BASIC TO MANAGEMENT STUDIES AND PRACTICES (1959 - page 165)

Studies to determine the identity, distribution, life history, ecological and physiological requirements, productivity, and grazing value of native and introduced plants of forest and related ranges are necessary for proper interpretation of the effects of grazing, climate, and other natural phenomena and to the development of sound management practices, particularly as they relate to livestock range and wildlife habitat. This research involves considerable cooperation with the various State universities and with the Agricultural Research Service.

Progress: Plant identification: In the Pacific Northwest, a key based on leaf, bud, and twig characters was prepared to allow identification of shrubs, at any season of the year and without reference to flowers or fruit (Garrison).

Also, for this same region, a plant symbol list was designed for use in automatic data processing (Garrison, Skovlin).

In Wyoming a key was prepared to allow identification of grasses in the Bighorn Mountains by vegetative characters (May).

Ecology and Physiology: At Benmore, Utah, a comparison of the root systems of big sagebrush (Artemisia tridentata) and rubber rabbitbrush (Chrysothamnus nauseosus) provides a partial answer for the differences in their effect on crested wheatgrass (Agropyron desertorum) yields. Taproots of big sagebrush are frequently restricted by a calcareous hardpan or salt accumulation in the lower soil layers, whereas the taproots of rabbitbrush are but little affected. When sagebrush roots are restricted, numerous lateral roots develop in the upper soil layers where they utilize surface soil moisture. Crested wheatgrass apparently is not able to compete with sagebrush and barren "Halos" develop at the perimeter of the shrub crowns. Poorly developed lateral roots of rubber rabbitbrush offer little competition to crested wheatgrass which grows profusely under and adjacent to the shrubs (Frischknecht).

Meter-square quadrats established on subalpine range in 1912-1913 in the Manti National Forest in Utah were recharted in 1959 and 1960. Important differences are apparent between grazed and protected areas. Infiltration is more rapid on areas protected from grazing than on grazed areas where annual trampling by sheep compacts the soil. In general, grasses predominate under grazing, and forbs are more abundant on the protected plots. There has been some increase of vegetation cover on both the grazed and ungrazed areas. It is most pronounced on the protected areas, but there are still areas that do not have adequate cover for soil stabilization. This slow rate of recovery is attributed to unfavorable microclimate and soil of low fertility (Plummer, Frischknecht).

Chemical analyses were completed to determine the seasonal fluctuation in carbohydrate reserves of bitterbrush (Purshia tridentata) in north central Washington. Tops and root systems were collected at each of the following growth states: spring dormancy, full leaf, full flower, initial twig growth--



early seed formation, seed maturity, cessation of growth, leaf fall, and winter dormancy. The percentages of total available carbohydrates in the various root and top strata all reflect pronounced seasonal fluctuation in the plant's food reserves, especially in the roots. The period of lowest carbohydrate in bitterbrush tops occurred in May when the plant was in the full flower stage. The characteristic lag in depletion of root reserves was apparent in that the lowest level was not reached until seed maturity, approximately six weeks later. After the period of excessive energy demand there is a steady accumulation of reserves in tops and an extremely rapid buildup in the roots. Thereafter, a gradual decline in reserves takes place through the early winter months, presumably the result of consumption by respiratory processes (McConnell, J. G. Smith).

Bitterbrush studies in California indicate that seed production is greatly influenced by precipitation of the previous growing season and that date of seed maturity is closely related to latitude and elevation. Endrin-arasan treatment did not effectively reduce rodent depredation on bitterbrush seed planted in the fall. Practically no bitterbrush seed is viable for more than one winter when it remains in the soil; therefore, natural establishment of bitterbrush seedlings is dependent upon seed production of the previous season (Nord).

In northern Arizona 20 native species all contained chemicals that inhibited the growth of wheat seedling radicles. Water extracts of the grasses showed less inhibitory effect than those of forbs, shrubs, and trees; however, extracts of all four classes of plants reduced radicle growth more than 50 per cent. Junipers (Juniperus spp.) showed inhibitory effects under field conditions, whereas grasses did not. Thus, the existence of a growth inhibitor in a plant extract does not necessarily mean that it has ecological importance (Jameson).

Crude protein levels of grasses and sedges in the Black Hills of South Dakota declined steadily from June through October. For example, protein content of Kentucky bluegrass (Poa pratensis) and roughleaf ricegrass (Oryzopsis asperifolia) dropped from between 12 and 18 per cent in early June to 7 or 8 per cent by mid-October. Phosphorus followed a similar downward trend through the season, but calcium remained about constant or increased as the plants matured. Plants growing on timbered range in partial shade contained significantly more crude fiber and less nitrogen-free extract than plants in open meadows. These differences in composition probably contributed to the much higher livestock utilization of bluegrass growing in open meadows (57 per cent) than that on adjacent timbered range (7 per cent) (Hurd, McEwan).



Reliable techniques are needed for measuring vegetation cover and production, forage utilization, and range condition and trend in order that range management practices may be properly evaluated. Although many advances have been made in this field, no methods have been developed that are wholly satisfactory. Development of improved methodology is therefore an important part of range management and wildlife habitat research.

Progress: Measurement techniques: At Bend, Oregon, trials in two kinds of overstory, birchleaf mountain-mahogany (Cercocarpus betuloides) and western juniper (Juniperus occidentalis), show that the spherical densiometer provides precise and accurate estimates of canopy cover directly above a line. The difference between two operators measuring total crown intercept on six 50-foot transects under curlleaf mountain-mahogany was 0.9 per cent. On eight transects under juniper, this difference was 0.7 per cent (Dealy).

Production measurements in California indicated that total herbage production as estimated by the point-center-quarter method was about 30 per cent less than production on the identical area by plot harvest. Other studies in California on increasing efficiency of clipped plot sampling and eliminating laboratory species-sorting by use of foliar hits before plot harvest have shown a very strong relationship between first foliar hits at a 45° angle and actual species composition by weight (Reppert, Reed, Duncan).

The relationship of utilization, stocking, and production of perennial grasses as a method of estimating stocking of experimental pastures where perennial grasses are the main forage-producing species indicate strong correlations. Multiple correlation coefficients, based on seven years of data of seeded crested wheatgrass in New Mexico, ranged from  $R = .9743$  to  $R = .9864$ . On a semidesert range in New Mexico, the multiple correlation coefficients, based on 15 years of data, ranged from  $R = .9471$  to  $R = .9794$  for black grama (Bouteloua eriopoda) and from  $R = .9459$  to  $R = .9788$  for all grasses. On a Thurber fescue (Festuca thurberi) range in Colorado the coefficients, based on four years of data, ranged from  $R = .0749$  to  $R = 1.0000$ , with five of the six pastures studied having an  $R$  value of .9656, or greater (Springfield).

Sampling and experimental designs: Three intensities of grazing by cattle in the Rocky Mountain region were found to have no effect on moisture content of herbage of two grasses and two forbs. It was concluded that separate herbage samples for correcting green weights to air-dry need not be collected for each grazing intensity (Reid).

Results from the California foothill annual type showed highly contagious distribution of nearly all species and groups. Therefore, the point-center-quarter technique is not well adapted for use in this annual type (Reppert, Duncan).



Title: GRAZING MANAGEMENT AND IMPROVEMENT OF FOREST AND RELATED RANGES  
GRAZED BY LIVESTOCK (1959 - page 167)

The main objective of this research is the determination of optimum intensities, seasons, and systems of grazing to obtain maximum production and efficient use of both native and improved livestock range on forest and related areas. Studies of range condition and trend standards and of burning for range improvement are also of major importance. Most studies involve cooperation with such agencies as the Agricultural Research Service, Soil Conservation Service, Bureau of Land Management, and State agricultural experiment stations, or with livestock associations or individual ranchers.

Progress: Grazing management of native range: On Mud Creek sheep allotment on the Uinta National Forest, Utah, utilization of the various forage species varied considerably during the summer months. A group of the most succulent species such as tall bluebell (Mertensia leonardi), cowparsnip (Heracleum lanatum), white polemonium (Polemonium albiflorum), and Oregon fleabane (Erigeron speciosus), were utilized heavily in June, but as they matured utilization declined. Utilization of American vetch (Vicia americana), niggerhead (Rudbeckia occidentalis), snowberry (Symphoricarpos spp.), bunchberry elder (Sambucus microbotrys), and young aspen (Populus tremuloides), increased in August and September. Most of the shrubs were not utilized until August when the forbs had matured and become dry (Hutchings, Julander).

Cows grazing under seasonlong management in the Blue Mountains of Oregon materially out-gained those under the 2-unit deferred-rotation system. Deferred-rotation grazing produced net summer cow gains averaging 16 pounds per head whereas seasonlong grazing furnished a 36-pound average gain. Calf gains during 1960 reflected differences between systems similar to gains by cows. Deferred-rotation produced calves that averaged 17 pounds lighter than calves under the seasonlong system. In this range site livestock performance, then, may actually be superior under seasonlong grazing. No differences in plant response have been observed during the initial 3-year period of the study (Garrison, Skovlin, Strickler).

Herbaceous vegetation on three meadows in the Big Horn National Forest in Wyoming was clipped annually from 1952-1955: (1) to 1-inch stubble height every two weeks, (2) to 3-inch stubble height every two weeks, and (3) to 1-inch stubble height at the end of the growing season. The most abundant plants were Kentucky bluegrass (Poa pratensis), tufted hairgrass (Deschampsia caespitosa), several species of sedge (Carex spp.), and white Dutch clover (Trifolium repens). Clipping to one inch every two weeks reduced the basal area of all grasses except Kentucky bluegrass, and of most sedges and forbs. Alpine timothy (Phleum alpinum), redtop (Agrostis alba), beaked sedge (Carex rostrata), and white Dutch clover disappeared completely. Basal area of Kentucky bluegrass and tufted hairgrass increased somewhat when clipped to three inches at 2-week intervals while that of most sedges and forbs decreased. Basal area changed very little between 1952 and 1956 on check plots which were clipped to one inch at the end of the grazing season (Johnson, May).



Yearling steers grazed at three intensities on Idaho fescue range in the Big Horn National Forest in Wyoming for about 2-1/2 months in summer and early fall from 1951 to 1958. At average stocking rates of 3.3, 1.3, and 0.8 acres per animal month, average use of Idaho fescue was approximately 6 per cent (light use), 34 per cent (moderate use), and 52 per cent (heavy use) by weight, respectively. The heavily stocked pastures produced the most beef per acre per grazing season but the lowest gain per head per day. The average daily gain per head was 1.89, 2.22, and 2.41 pounds for heavy, moderate, and light use, respectively, whereas average seasonal gain per acre was 69, 57, and 22 pounds, respectively (Johnson, May).

Idaho fescue plants on granitic soils were usually grazed more heavily than those on sedimentary soils, and maintained better vigor on soils from sedimentary rock. Even light grazing reduced the vigor of plants growing on granitic soils. As utilization of Idaho fescue increased above 40 to 45 per cent, production not only decreased, but less desirable species began to increase. These changes were more pronounced on granitic than on sedimentary soils. It was concluded that management of the ranges studied should be based on not more than 40 to 45 per cent utilization of Idaho fescue by weight (Johnson, May).

Steer weight gains and vegetation response in the Bighorn Mountains in Wyoming were compared on pastures: (1) grazed seasonlong (June 20 to September 20) with objective of 50 per cent use of Idaho fescue (moderate use), (2) grazed in 3-pasture rotation (animals per unit area comparable to moderate use), (3) grazed in 3-pasture rotation at a heavy rate (50 per cent more cattle than for moderate use). In the first two years of study steer weight gains per head were highest under moderate rotation grazing averaging 2.20 pounds per day as compared to 1.89 pounds per day under moderate seasonlong and 1.83 pounds per day under heavy rotation. Gain per acre averaged 53.56 pounds and 64.59 pounds under moderate rotation and heavy rotation, respectively, as compared to 48.94 pounds under moderate seasonlong grazing. This is in direct contrast to results of studies in the Blue Mountains of Oregon where best gains were produced by seasonlong grazing (Johnson, May).

Similar reduction in utilization under rotation grazing was shown on Pole Mountain, Wyoming. Grazing four units on a straight rotation system from June 1 to October 15 resulted in 22 per cent lower utilization in the bottoms with no increase on the uplands. On another allotment, where each unit was deferred completely every fourth year and grazing was rotated on the other three units, utilization decreased about 10 per cent in all types but the pattern of use did not change (Johnson, May).

Grazing Thurber fescue (Festuca thurberi) grassland and aspen (Populus tremuloides) range on Black Mesa in western Colorado at light (22 per cent by weight of the perennial grasses), moderate (35 per cent) and heavy (50 per cent) rates for four years (1957 to 1960, July 15 to October 1) has not appreciably affected yearling steer weight gains (Turner).



Grazing management of improved ranges: After nine years, crested (Agropyron cristatum) and desert wheatgrasses (A. desertorum) continue to be the most productive grasses in both the juniper-pinyon and sagebrush types of the Inter-mountain region. Heavy mortality was sustained by intermediate (A. inter-medium), pubescent (A. trichophorum), and tall wheatgrasses (A. elongatum), on the heavy soil of the sagebrush type, both under grazing and protection. On the lighter rocky soil of the juniper-pinyon type, survival of intermediate and pubescent wheatgrass was excellent, but tall wheatgrass was severely thinned. Russian wildrye (Elymus junceus) survived, as well as crested and desert wheatgrasses, but was only about two-thirds as productive. The bearded bluebunch wheatgrass (A. spicatum) failed to persist well on the heavy soil under protection or grazing. On the lighter soil it maintained itself well under protection but virtually died out under grazing. In contrast, a beardless form of bluebunch wheatgrass maintained itself well with either protection or grazing on the lighter soil, but failed on the heavy soil. It appears that the sandier soil, underlain by rocks, can sustain a greater variety of species than the deeper and apparently more productive soils with higher moisture-holding characteristics (Plummer, Frischknecht).

In Manti Canyon, Utah, on high summer range, smooth brome (Bromus inermis) and meadow foxtail (Hordeum nodosum) seeded prior to 1956 continued to increase in both production and cover. In 1956 smooth brome yield was only 203 pounds per acre as compared to 713 pounds in 1960. Yield of meadow foxtail for the same years was 39 and 139 pounds per acre, respectively. Other seeded grasses varied in their response. Tall meadow oatgrass (Arrhenatherum elatius), orchardgrass (Dactylis glomerata), and timothy (Phleum pratense) decreased substantially. Reed canarygrass (Phalaris arundinacea) made a small increase in both production and cover. Utilization of the introduced grasses averaged 60 per cent as compared to only 8 per cent for the native species. Cattle gained 1.1 pounds per head per day, and calves 1.8 pounds. Stocking rates averaged approximately 2.1 acres per cow month (Plummer, Frischknecht).

Grasses that have persisted as relatively poor stands on the juniper-pinyon site are Great Basin wildrye (Elymus cinereus), bluestem wheatgrass (Agropyron smithii), and Indian ricegrass (Oryzopsis hymenoides). Lack of adaptation of the strains rather than of species probably explains their poor showing. Sparsely scattered plants of Ladak alfalfa have persisted on the juniper-pinyon site. Mountain rye (Secale montanum), smooth brome, thickspike wheatgrass (Agropyron dasystachyum), and streambank wheatgrass (A. riparium) have failed to maintain themselves except as occasional isolated individuals. Cattle have shown little preference in their selection of the seeded grasses. In contrast, deer and sheep have shown a strong preference for Russian wildrye, particularly in the spring. Preference of intermediate wheatgrass, pubescent wheatgrass, crested wheatgrass, and desert wheatgrass follow in about the order named (Plummer, Frischknecht).

Crested wheatgrass (Agropyron desertorum) was found to be good lambing range in northern New Mexico. Average daily gains per head for lambs on crested wheatgrass (spring) were 0.61 pound as compared to 0.55 pound per day for lambs on native range. The lambs moved from the crested wheatgrass to native range for the summer gained 0.42 pounds daily for the summer period and 0.48 pound



gain for the season, whereas the daily gain on native range was 0.38 (summer) and 0.43 (seasonal). Yields of crested wheatgrass varied from 399 to 1565 pounds per acre between 1957 and 1960 because of differences in precipitation. Differences in grazing intensity (84, 72, 53, and 39 per cent average utilization over the three years) had no appreciable effect on crested wheatgrass production, but with the short 30-day grazing period there was ample time for regrowth and recovery of plant vigor (Springfield).

In contrast, the response of crested wheatgrass to grazing was somewhat different at the Manitou Experimental Forest, Colorado. Measurements made in 1960, on areas grazed spring-summer and fall for 9 to 12 years at four intensities from 30 to 80 per cent, show that the higher the utilization the lower the amounts of crested wheatgrass and litter and the higher the amounts of bare soil and rocks. Measurements of individual crested wheatgrass plants on each use area show that: (1) Average basal diameter was larger at the 30 per cent use rate than at the other three rates, (2) Density of living tillers within each plant varied inversely with degree of use, and (3) Average number of flower stalks per plant increased greatly on the 65 and 80 per cent use areas. Herbage production of crested wheatgrass in 1960 was 848 pounds per acre, air-dry, on the 30 per cent use area and 645 pounds per acre on the 80 per cent use area. Production of the 45 and 60 per cent use areas was intermediate (Currie).

Heavy grazing (up to 77 per cent use by weight), also for a short spring season of about 30 days, of crested wheatgrass by cattle in northern New Mexico for periods of five to eight years had no undesirable effect on herbage production. In fact, herbage production in pastures grazed at the heaviest rate increased 589 pounds per acre (air-dry) from 1952 to 1959 and the increase on the lightest grazed pastures was only 328 pounds during the same period (Springfield).

Influencing livestock distribution and supplementing range forage: Blue Mountain, Oregon, weather conditions appeared to cause fluctuations in crude protein content. The seasonal decline in protein of principal forage-producing species responded to the amount and seasonal distribution of mid-summer precipitation. Cattle weight gains over an 8-year period were also found to be associated with the amount and pattern of mid-summer precipitation. Seasonal forage quality and the resulting cattle weight gains were therefore closely related to soil moisture conditions. Forage plants growing on the predominant soil type (Rock Creek soil series) depend on moisture supplied by a soil reservoir which averages only seven inches in depth to bedrock. Spring precipitation usually provides sufficient moisture for production of an adequate forage crop. However, because of rapid soil moisture depletion during late spring, plants are dependent on additional summer precipitation for continued activity and retention of nutrient quality (Garrison, Skovlin).

Condition and trend of livestock range: By a comparison of 1938 and 1956-57 records on a subalpine grassland in eastern Oregon, it was possible to determine the degree of vegetation recovery for areas exhibiting one of four classes of soil loss before improved grazing management was inaugurated. The information on 18 years of recovery will be helpful in planning management of other deteriorated subalpine areas and in predicting degree of recovery attainable (Garrison, Strickler).



Re-inventory of three Starkey exclosures after 17 years of protection from livestock use confirmed the point that a drainage phase difference within a soil series limits vegetation development on many of the so-called flat bunchgrass ridges of northeastern Oregon. More specifically this means these sites have never supported a wheatgrass cover except where slopes exceeded three to five per cent (Garrison, Strickler).

Vegetation types in climax or near climax condition in the juniper zone have been classified and characterized at Bend, Oregon. The most useful vegetation characteristics were foliage cover, plant constancy, and total basal area of herbaceous perennials. The most important soil characteristics segregating specific types were bare soil surface, percent total nitrogen and organic matter in the surface horizon, and total available soil moisture storage capacity (inches of water) in the 2- to 14-inch soil zone. The last soil characteristic includes (1) bulk density, (2) stones on and in the soil, and (3) the wilting point and field capacity of the soil. The only topographic feature that had diagnostic value was slope aspect. Slope steepness or slope position appeared to have little influence on habitat type occurrence or distribution. Individual taxonomic soil units were not directly associated with individual taxonomic vegetation units. A close correlation between taxonomic soil and vegetation units at the soil series level can usually be expected only where soils are relatively mature expressing longtime environmental interactions (Driscoll).

Native mountain bunchgrass range in good condition on Black Mesa in western Colorado produced 790 pounds of herbage per acre in 1960, of which 445 pounds were grasses and 345 pounds were forbs. Similar adjacent range, sprayed with 2,4-D in 1959 to control forbs, produced 1791 pounds of herbage per acre in 1960, of which 1719 pounds were grasses and 72 pounds were forbs. As previously reported, such changes have been accompanied by marked reduction in gopher numbers (Turner).

Use of fire on livestock range: In Arizona, studies showed that fire killed about two-thirds of the velvet mesquite (Prosopis juliflora var. velutina) seedlings 8 and 12 months old and four inches to six inches tall. The remaining one-third of the seedlings were top-killed but sprouted from the base and were usually in sufficient numbers to fully occupy the site in later years if not destroyed (Pond).

Four years after a 1953 wildfire in a pinyon-juniper area on the Hualapai Indian Reservation in northern Arizona, crested wheatgrass seeded on the burn produced 390 pounds of herbage per acre compared to less than 50 pounds per acre of blue grama on adjacent unburned and unseeded areas (Jameson).

Eight growing seasons after a wildfire in chaparral in central Arizona, crown cover of sprouting shrubs, primarily shrub live oak (Quercus turbinella), had reached 50 per cent on a grazed area and 38 per cent on an adjacent ungrazed area (difference not significant). This cover is similar in amount to that on adjoining unburned areas. Basal cover of weeping lovegrass (Eragrostis curvula), seeded soon after the burn, increased for the first six growing seasons on the ungrazed area but dropped sharply on grazed and ungrazed areas from 1956 to 1958. However, soil profile measurements indicate that a mixed



grass-shrub cover is more effective than shrub cover alone in retarding soil movement. Annual soil movement (removal plus deposition) averaged 0.018 feet during the 1952 to 1956 period, when lovegrass basal area was high and summer rainfall averaged 5.77 inches. In 1957-58 with low lovegrass basal area and average summer rainfall of 3.95 inches, annual soil movement averaged 0.034 feet (Reynolds, Pond).

Title: MANAGEMENT AND IMPROVEMENT OF WILDLIFE HABITAT ON FOREST LANDS AND RELATED RANGELANDS

Most of these studies are made in cooperation with the fish and game departments of the respective States and/or the U. S. Fish and Wildlife Service, and are concerned with determination of proper use of game forage, procedures and criteria for judging game habitat condition and trend, and methods for revegetating depleted game habitats by such practices as seeding and burning. Rehabilitation is especially needed on winter game ranges where damage to desirable shrubs has been severe and perennial herbaceous cover has been greatly reduced, permitting invasion of undesirable annual plants and accelerated erosion.

Progress: Big-game grazing management: Studies of mule deer herd productivity in the Intermountain area show that summer range condition is a very important factor. A herd on a very poor summer range in central Utah produced only two-thirds as many fetuses or newly born young as a herd on a very good summer range in southern Idaho. Winter ranges during the period of study were similar on the two areas (Julander).

Stand development of bitterbrush in the central Oregon juniper zone is closely associated with soil and topographic features. Soil characteristics limiting its development include: (1) nature of the underlying material, (2) texture and structure of the subsoil, (3) stoniness of the solum, and (4) depth of the solum. Slope aspect appears to be the only topographic feature limiting bitterbrush development. Stand development of bitterbrush decreases as effective soil depth lessens, soil texture becomes finer, soil structure becomes strongly developed, proportions of stones in the soil decrease, indurated hard pans become evident, and slope aspect changes to the north (Driscoll, Dealy).

Three spray repellents, 7AC, TMTD, and COPPER OMADINE have proven effective in reducing mule deer browsing to planted ponderosa pine seedlings at Bend, Oregon. There was no significant difference between repellents but highly significant differences between the chemicals, a control with no protection, and a control with trees covered with brush. Analyses also showed a significantly higher incident of browsing in the winter and spring as compared to the fall season and that trees covered with brush were browsed less in the spring than trees not covered and with no repellent (Driscoll, Dealy).

Special practices for habitat improvement: In Utah, establishment of shrub species from direct seeding, as well as by cuttings and transplants, is less successful than for herbs. Much of the loss occurs during the first three years. However, two species showing good promise are rubber rabbitbrush and big sagebrush. Approximately 80-per cent success has been obtained in the



establishment of wildings of these species over a 3-year period. Suitable 2- to 3-year-old plants are readily available from roadside borrow pits and elsewhere. Their strong natural spreading qualities, high seed production and viability make them ideal for transplanting, and it appears that establishment of groups at 100-ft. intervals will provide reasonably good stands from natural reproduction in a period of 5 to 10 years. Winterfat (Eurotia lanata) is another species that can be successfully transplanted although initial establishment is not as successful as for big sagebrush and rabbitbrush (Plummer).

At Boise, Idaho, on range used in winter at the rate of approximately 12 deer-days per acre, young bitterbrush shrubs established by direct seeding have shown a consistent pattern of regrowth following winter utilization. In October 1957, the mean maximum height of two-year-old unprotected plants was four inches. During the succeeding three winters, deer use averaged 1-1/2, 2, and 3 inches of the current twig growth, the total of which averaged 3-1/2, 4-1/2, and 5-1/4 inches. As a result, unprotected plants had a mean maximum height of 10-1/2 inches after five growing seasons. Bitterbrush in an enclosure protected from browsing had a mean maximum height of 3-1/2 inches in October 1957. Growth averaged 4-1/4, 4-1/2, and 5-3/4 inches the following three summers, and the mean maximum height of plants after five growing seasons was 18-1/4 inches. Average maximum crown diameter was nearly equal to the average maximum height of the browsed and unbrowsed plants, i.e., 10 and 18 inches, respectively (Basile, Ferguson).

Production estimates and relative ratings were made on grasses and legumes planted for elk range improvement at 6,000 feet in 1953 on Sweetgrass Ridge, Washington. Timothy, pubescent wheatgrass, orchardgrass, and blue wildrye (Elymus glaucus) maintained excellent ratings and high forage production throughout the eight growing seasons. Ratings of big bluegrass, meadow brome (Bromus erectus), slender wheatgrass (Agropyron trachycaulum), dryland timothy, and intermediate wheatgrass have fluctuated from fair to excellent. Mountain brome, which maintained excellent ratings through 1955 declined sharply between 1956 and 1960 and now stands at the bottom of the list with sheep fescue and hard fescue. Bearded wheatgrass was the only species that failed to produce a satisfactory stand the first growing season. All legumes (Sevelra, Nomad, and Ladak alfalfa; chickpea milkvetch) looked very promising at the end of the first growing season, but failed somewhat by the end of the second growing season, and were rated failures in the third growing season (J. G. Smith, McConnell)

Competition is an important factor in bitterbrush establishment. On a good winter range bitterbrush site in California, plant vigor suffered where bitterbrush stocking was more than 2,200 plants per acre. In a test on range seeded to crested wheat it was found that for best results bitterbrush should be planted in the openings and wherever possible at least two feet away from each grass clump. In an area of current bitterbrush die-off near Mt. Hebron, California, removal of the perennial grass understory nearly doubled bitterbrush leader length and number of leaders per branch (Hubbard).



Antelope bitterbrush (Purshia tridentata) continued to out-perform other shrub species being tested for revegetating winter deer range in the Black Hills of South Dakota. Three methods of establishment were used on each of two sites: a burned area and a timbered area. Methods of establishment were: (1) potted seedlings transplanted in the spring, (2) seeds planted in the fall, and (3) nursery stock planted in the spring. Survival of potted seedlings was high and all species grew equally well although average growth was no better than with other methods. Three years after direct seeding, antelope bitterbrush plants averaged 11.4 inches high on the burn and 5.5 inches high on the timbered site. Other seeded species, including true mountain-mahogany (Cercocarpus montanus), chokecherry (Prunus virginiana), pincherry (P. pennsylvanica), snowbrush ceanothus (Ceanothus velutinus), common juniper (Juniperus communis), silverberry (Elaeagnus argentea), bearberry (Arctostaphylos uva-ursi), inland ceanothus (C. ovatus) and serviceberry (Amelanchier alnifolia) showed generally lower percent germination and survival and poorer growth (Hurd, McEwan).

Title: RANGE-USE RELATIONS PERTINENT TO MULTIPLE-USE MANAGEMENT ON FOREST AND RELATED RANGES (1959 - page 170)

Objectives of this research are to determine: (1) the effects of timber production and cutting practices on forage for livestock or big game and reciprocal effects of forage production and grazing on timber (particularly reproduction), (2) the nature and degree of competition and compatibility between livestock and wildlife on various types of forest and related ranges, and (3) relations between grazing and watershed management on both forest and related ranges. Such research is needed as a basis for adjustments in livestock or game numbers and in management practices necessary for resolving conflicts in the various uses on both public and private lands.

Progress: Range-timber relations: Foliage cover of shrubs, grasses, and forbs increased on two deer winter range study areas in the Fisher River drainage, Montana, during the years 1949-1959, as a result of opening the timber stand by logging. Significant increases in understory vegetation occurred in areas open to both light and heavy deer use as well as in areas closed to deer. Shrub cover increased more than grasses or forbs in all areas. It is expected that this improvement in deer forage will result in less damage to reproduction of ponderosa pine (Schmautz).

Cover of herbs and shrubs was initially reduced an average of 47 per cent in the selectively logged pine stands of eastern Oregon and Washington, but original amounts of these species were regained by the seventh year after logging. However, on the most severely damaged skid-roads, regeneration of vegetation appeared arrested at a stage equal to that existing two years after logging. Slash burning following logging also retarded recovery. On an area in eastern Washington where slash was disposed of by fire, total understory cover seven years after logging was still 16 per cent less than it was before logging (Garrison, J. G. Smith).

Range-watershed relations: Alkali sacaton (Sporobolus airoides) was grazed 15 to 50 per cent more than galleta (Hilaria jamesii) by yearling cattle and by cows with calves on semidesert winter-spring range in northern New Mexico where these two species furnished about equal amounts of forage. Yearling cattle utilized the grasses more uniformly over tough and rocky terrain and less closely around stock tanks than did cows with calves. Management under these conditions should be based solely on proper utilization of alkali sacaton, which is considered a better species for both range and watershed purposes (Springfield).

Title: RANGE PEST RELATIONS ON FOREST AND RELATED RANGES (1959 - page 171)

This research is concerned with effects of rodents, insects, and diseases on vegetation and soil of livestock range and wildlife habitat and with reciprocal effects on vegetation and soil condition and grazing practices on rodent or insect populations or disease incidence.

Progress: Rodent-range relations: Recently published results of the effect of pocket gophers on vegetation following removal of aspen from a watershed area in Utah showed gophers to be a primary cause of plant cover deterioration. Both the aspen-cleared and uncut control areas were protected from livestock grazing. Gophers on the cleared area were nearly twice as abundant and damage to perennial vegetation was much greater than on the control area (Julander).

In big sagebrush areas in northern and western Nevada, protection from small herbivorous mammals for two decades has resulted in plant composition changes notably different from changes where livestock only were excluded. The most striking difference was in the greater percentage of perennial forbs that developed under rodent protection (Holmgren).

Excluding pocket gophers for three years from plots on Black Mesa in western Colorado resulted in increases in grass and litter cover, and consequently a decrease in bare ground. Forbs also increased, 36 and 21 per cent, respectively, on the gophers-present and gophers-absent plots, but the difference between the two treatments was not significant. The changes in grasses, litter, and bare ground on both series of plots between 1957 and 1960 were apparently related to the reduced gopher numbers since with fewer gophers, less soil was deposited on the ground surface, less litter was covered by soil deposition, and grasses were disturbed less by burrowing activity (Turner).



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